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ABSTRACT

This guide was developed jointly by members from the Departments of social studies, mathematics, English, and science. It sets forth the methods, materials and procedures of operation for the interdisciplinary teaching of this course. The overall objectives of the course are: 1) to teach the elements and process of decision-making; 2) to improve the process of communication; 3) to develop an awareness of the interaction between society and technology; and, 4) to develop an awareness of the present level of technology and the directions technology may take in the future. Student centered problem solving groups will deal with relevant real life situations. Small, medium, and large groups will be randomly selected and flexibly scheduled. The units are: Elements of Decision-Making; Communications; Nation Building; International Simulation including computer instruction; The Environmental Crisis; Labor vs. Management; and, Major Urban Problems. (Author/SBE)

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A Teacher Guide For The Course

"TOWARD THE YEAR 2000"
(A Multi-disciplinary Course)

A Publication of The Multi-disciplinary Team
At Cherry Creek High School

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John Christensen
William Cox
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PREFACE

The Cherry Creek team has prepared this guide in the hope that it may provide assistance for those who may be interested in some type of multi-disciplinary teaching. We do not advance this guide as the exclusive method of multi-disciplinary teaching nor do we believe that what is contained herein is, by any means, the final or best word on this subject. Rather, we are presenting this as the outcome of considerable deliberation on the part of four teachers at a suburban high school in Metropolitan Denver. We hope that the results of our deliberations may serve to stimulate others to develop multi-disciplinary courses which are relevant to their own teaching environments and professional aspirations.

This guide could not have been prepared without the encouragement, support, and suggestions of several colleagues. We, therefore, gratefully acknowledge the assistance of:

Dr. George Maler
Assistant Dean, College of Engineering, University of Colorado.

Mr. Dean Larsen
Consultant, Jefferson County Public Schools.

Mr. James Metzdorf
Consultant, Colorado State Department of Education.

We are pleased to have been associated with them and we look forward to the continuation of a pleasant and productive relationship.

John Buchanan
John Christensen
William Cox
Karen White

I. Introduction

This guide sets forth the methods, materials, and procedures of operation for the multi-disciplinary team teaching of the course, "Toward The Year 2,000." The guide was developed jointly by team members from the Departments of Social Studies, Mathematics, English, and Science at Cherry Creek High School during the school year 1969 and during the summer of 1970. Included in the guide are the principles of operation, a listing of the units to be taught, responsibilities for each unit, a tentative schedule, and information about the units.

The team believes the objectives of the course are:

1. To teach the elements and process of decision making.
2. To improve the process of communication.
3. To develop an awareness of the interaction between society and technology.
4. To develop an awareness of the present level of technology and the directions technology may take in the future.

The team believes that the course should:

1. Be problem oriented. The problems dealt with should be relevant to the students and should illustrate real life situations.
2. Be student centered. Problem solving groups are the central operating unit of the course with the teacher serving as an organizer of activities and as a resource person in the problem solving process.

II. Principles of Operation

The team agrees that the following principles should govern the operation of the course:

II. Principles of Operation (cont.)

A. The course will proceed according to a flexible time schedule with each week's schedule being determined by the team during its weekly planning sessions. The most effective use of time and student groupings will be of utmost concern to the team in determining the schedule.

B. Responsibility for each unit will be rotated. Team responsibilities shall be organized as shown in Section IV.

C. The students enrolled in the course will be arranged into three types of groups. Each small group will be composed of approximately six students. Each of the medium groups will consist of two small groups or approximately twelve students. The large group will consist of all the students in the course. The type of group to be utilized will be determinte by the nature of the activity. Groups may be organized in a manner of random selection, by teacher selection, by student selection or by means of sociogram. An attempt will be made to ensure that each team will have the same proportion of girls and boys as does the total class.

D. The evaluation of student performance for the determination of grades will be done cooperatively by all members of the team.

E. There shall be a minimum of one hour of common planning time per week. The office hours of the team members will be posted in the team office.

III. Team Organization
(Team Leader)

A Team Leader will be selected by the team for a period of one year. It will be the responsibility of the Team Leader to:

A. Supervise the over-all operations of the team.

B. Order books, films, and materials.

C. Monitor the budget for the course.

D. Supervise administrative procedures such as attendance, tardies, disciplinary concerns and records.

III. Team Organization (cont.)
(Team Leader)

E. Prepare the agenda for and preside over each team planning session.

F. Supervise the team in the evaluation of student performance for the determination of grades.

Beyond this, team organization and responsibilities are based on a unit of work and will be rotated with all team members assuming leadership roles in the teaching of units. The unit leader is responsible for:

A. The development of the unit of work. This includes a list of objectives, a time schedule showing the types of activities, types of groups and the assignments of other team members.

B. The development of a detailed description of the activities planned. This description will incorporate the thinking of all team members as developed in the planning sessions. This plan should include items such as descriptions of films to be used, factual information for students, problem sheets, overhead projectual masters and a list of resource persons and/or other materials.

C. The development of evaluation and feed-back techinques for the unit.

D. Communicating the plan for the unit to other team members.

IV. UNITS OF WORK

The following table gives the units of work and the person in charge of development.

UNIT	TITLE	TIME	PERSON RESPONSIBLE
I.	Decision Making	4 weeks	Cox
II.	Communication	1 week plus one weekend	White
III.	Georgraphy and Internation simulation	5 weeks	Buchanan
IV.	Understanding Computer Concepts	4 weeks	Cox
V.	The Environmental Crisis I.		
	A. Pollution	3 weeks	Christensen
	B. Population Growth	3 weeks	
VI.	Man-Machine Interaction	4 weeks	Buchanan
VII.	Labor-Management Simulation	4 weeks	Buchanan
VIII.	Urban Problems	3 weeks	White
IX.	The Year 2,000	4 weeks	Christensen

V. UNITS OF STUDY

The following pages contain the units of study for the school year. Each unit will contain:

A. A summary sheet showing objectives, activities and evaluation procedures.

B. A description of the unit including both teacher and student materials.

C. A description of the evaluation and feed-back procedures.

D. A bibliography.

ELEMENTS

OF

DECISION-MAKING

UNIT I

STUDENT MATERIALS

UNIT: ELEMENTS OF DECISION-MAKING

Objectives: After studying this unit, each student should:

I. Know the phases in the decision-making process.

II. Given a problem be able to apply the decision-making process to arrive at a solution.

III. Be aware of major difficulities in making decisions.

IV. Be familiar with various types of decisions.

V. Be able to evaluate a decision.

Activities: I. Develop and discuss the decision-making process.

II. Analyze and develop solutions to several problems of varying difficulty.

III. Evaluate decisions made by others.

Evaluation: Students will be given a case problem that involves decision-making. They will show the various phases in the decision-making process and how they are illustrated by the case. They will also list such things as the factors associated with making this decision, the type of decision involved, and how they might evaluate the decision.

UNIT: ELEMENTS OF DECISION-MAKING

INTRODUCTION

We all have many decisions to make each day of our lives. Most of these decisions involve or affect other people, some are important, some are irreversible, some are made "with the facts," others from an emotional base; but no matter who makes the decision, or how the alternative courses of action are considered each of us uses some decision-making process. It is the purpose of this unit to discuss some of the principals upon which decisions are made and to present an approach to problem solving which will be useful to you. There is no one single, simple problem solving approach. Solving problems is a practical art, like skiing or swimming, or playing baseball. You learn it primarily by imitation and practice. This unit or course cannot offer you a magic key that will solve all problems or always make the correct decision, but it can offer you some examples for imitation and many opportunities for practice. If you wish to learn to swim you must go into the water, and likewise if you wish to become a problem solver you must solve many problems.

Problem solving is a concept that is a common thread between the disciplines represented in this course. Let us briefly consider the approaches used in the various disciplines.

John Dewey presented the following approach for solving problems in his book published in 1910:

1. A feeling of perplexity.
2. A definition of the problem.
3. Formulation and testing hypotheses.
4. Development of the best solution by reasoning.
5. Testing the conclusion; which leads to its acceptance or rejection.

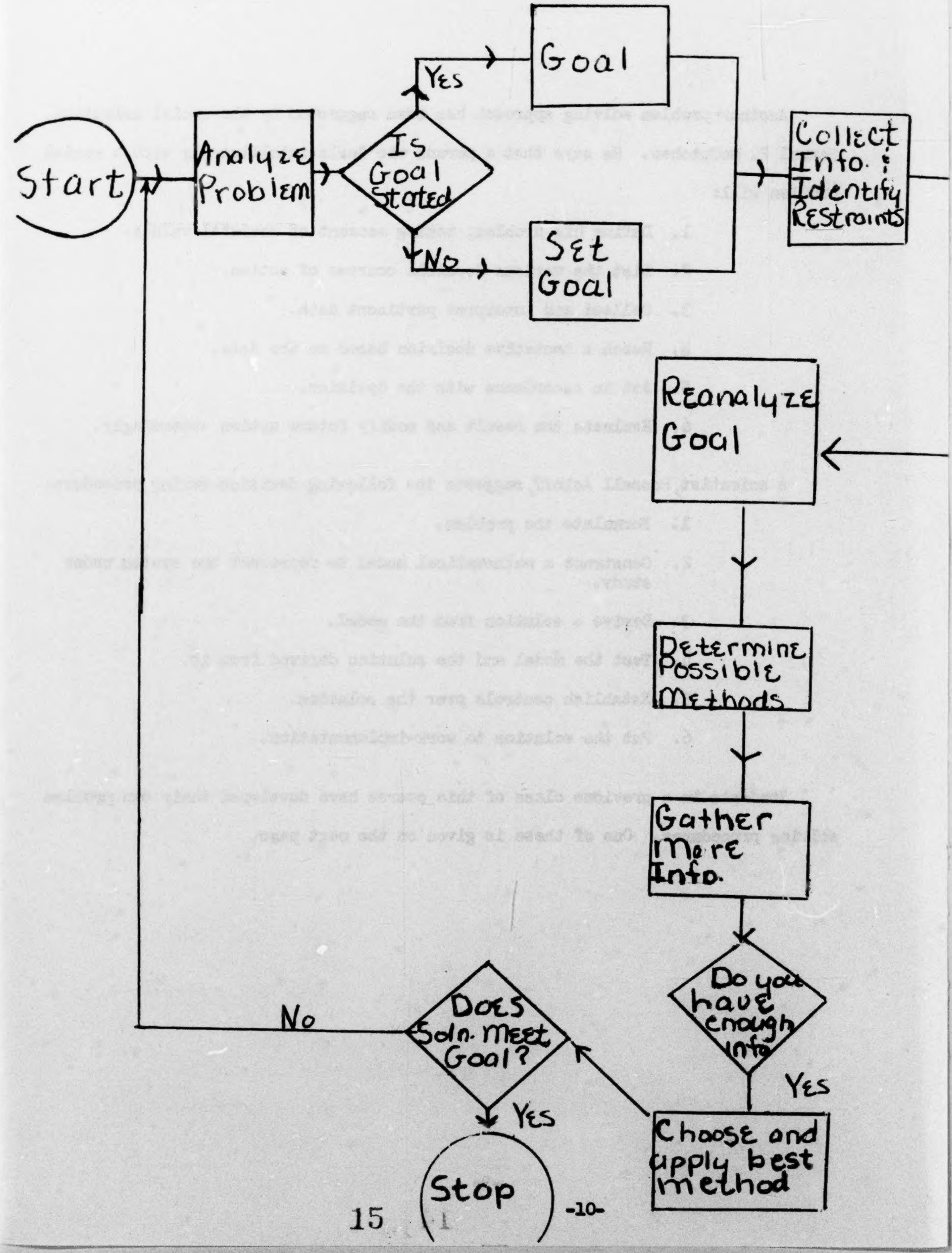
Another problem solving approach has been suggested by the social scientist, Samuel P. McCutchen. He says that a person who deals intelligently with a social problem will:

1. Define his problem, taking account of societal values.
2. List the various feasible courses of action.
3. Collect and interpret pertinent data.
4. Reach a tentative decision based on the data.
5. Act in accordance with the decision.
6. Evaluate the result and modify future action accordingly.

A scientist, Russell Ackoff, suggests the following decision-making procedure:

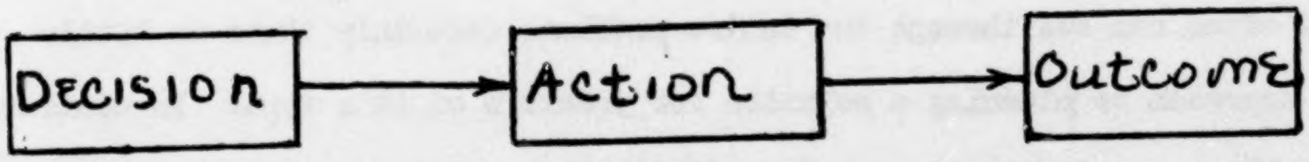
1. Formulate the problem.
2. Construct a mathematical model to represent the system under study.
3. Derive a solution from the model.
4. Test the model and the solution derived from it.
5. Establish controls over the solution.
6. Put the solution to work-implementation.

Students in a previous class of this course have developed their own problem solving procedures. One of these is given on the next page.

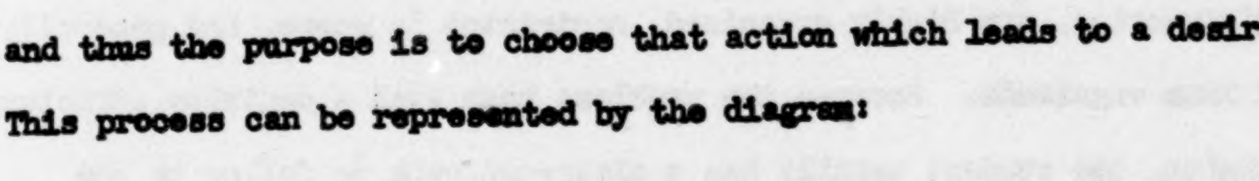

Start
Analyze Problem
Is Goal Stated
Yes
No
Goal
Set Goal
Collect Info. : Identify Restraints
Reanalyze Goal
Determine Possible Methods
Gather More Info.
Do you have enough info
Yes
Choose and apply best method
Does Soln. Meet Goal?
No
Yes
Stop

Although there is not one right procedure for making all decisions, there appear to be several aspects of the procedure that are common to most.

Generally speaking, decisions require the selection of a course of action and thus the purpose is to choose that action which leads to a desirable outcome. This process can be represented by the diagram:



Although not always true in general, different actions lead to different outcomes. To make decisions we must trace down the consequences of alternative lines of action. The outcomes for various courses of action are usually obtained from our past experiences. Thus, in making a decision we must be concerned not only with the present and the future, but also the past as shown below:



The process of decision making as presented above is somewhat oversimplified yet it contains three basic steps in the decision-making process:

1. **The outcomes for each action are predicted.**
2. **The outcomes are evaluated in terms of some scale of desirability.**
3. **Some rule for decision which is based on the purposes is then used to select the desired outcome.**

If we are to develop an useable approach to problem solving or decision-making, we must have considerably more detail than that given above.

In school, the emphasis is usually on teaching subject matter material. Consequently, the assigned problems are designed to provide understanding of the subject matter. Invariably, such problems show the desired principles with a minimum of distraction, are highly organized, restricted in scope, and generally have a limited time magnitude. Because the problems have such a definite structure and confined limits, the student usually has a clear-cut path to follow to the solution and often can see through the entire problem. Certainly there is little need for an approach to planning a solution for problems of this type. In contrast real-life problems are frequently complex, difficult to define, broad in subject matter coverage--usually involving several disciplines--and may be of long duration. Typical problems may require weeks or months to solve, and may entail the solution of many smaller subproblems. Often the problem solver can see no further ahead than the definition of his problem. Thus an organized plan or approach to problem solving helps him evolve a time schedule that will move him toward the problem solution in an efficient manner. Often the decision maker (or problem solver) is plowing new ground and proceeding in the dark. During these periods he has only faith in his ability to solve the problem and confidence in the approach, to serve as his guide and to stimulate his enthusiasm.

Hopefully then, it is apparent that the decision maker needs an organized plan or approach as an aid in solving problems or making decisions. Some of characteristics he will want to include in his approach are:

1. It should be flexible enough to be used in a wide variety of problems.
2. It should enable him to express his problem and his progress to himself, his colleagues, and his superiors.
3. It should serve as a guide for scheduling and planning his work.
4. It should be compact and easily retained in his mind.
5. It should be detailed enough to provide perspective and

direction in complex problems.

6. It should be dynamic and capable of changing as his needs change.

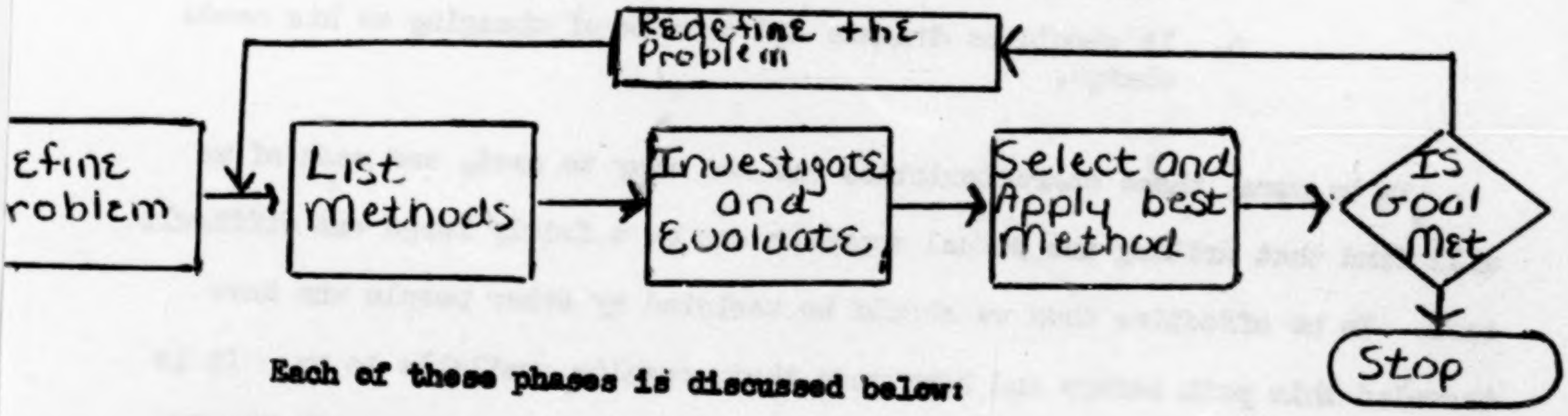
To be sure, these characteristics are not easy to meet, and each of us will find that writing the actual approach can be a fairly large and difficult task. To be effective then we should be assisted by other people who have traveled this path before and have made their results available to us. It is for this reason the teachers of this interdisciplinary course have developed the approach presented here.

This approach was designed to enhance the ability of the problem solver in developing his own individual decision making procedure. There is no doubt that the approach can satisfy this function if it is viewed properly. The problem solver should keep in mind that thinking about problems is a complex experience. The approach outlined here may not be compatible to all; since each students' background,personality, understanding, and word connotations are different. If it is not, each student should then learn what he can from the approach and construct one that is in harmony with himself. In any event, if the approach is to be useful, it must become a part of your personal philosophy--believed in and used. This means that you must try the approach, modify it, and retry it. It is your responsibility to convince yourself of its worth!

Following is the problem solving approach we propose:

Phase I Define the problem.
Phase II List methods of solution.
Phase III Investigate and evaluate each method.
Phase IV Select and apply best method.
Phase V Test the results.

This can be represented symbolically as shown below:



Each of these phases is discussed below:

DEFINE THE PROBLEM

An old adage states, "A well defined problem is half solved." Perhaps this is a bit more picturesque than true, but it does give a measure of the importance of an adequate problem definition. Decision makers find difficulty in adequately defining a problem for two reasons: 1.) their interpretation or the word "adequate" and 2.) their disregard for the use of an organized procedure to determine an "adequate" definition.

The line between an overdefined and the poorly defined problem is a difficult one to discern. No problem is ever completely defined because tomorrow always brings new facts, new circumstances, and fresh thoughts which modify the outlook. Indeed progress requires the reexamination of problem goals and thus a restatement of the problem definition. Furthermore, no two people will define a given problem alike; their experience and interpretation of the circumstances as well as their ability to discover the essential aspects of the problem differ. But, with every problem solver there will be some point of "adequate" definition. This point is the minimum definition consistent with the decision makers' ability to proceed toward the solution of the problem, and be confident that when a solution is developed and implemented, it can be evaluated in terms of the problem definition.

On first reading, this probably sounds quite confusing, however, if it is studied and applied it will prove to be useful and sufficient and thus of course "adequate."

The decision maker uses an approach because he recognizes the need for organization in the efficient solution of his problems. It seems only natural then that he should be organized in his application of the various phases in decision-making. Thus, we suggest following this plan for defining the problem:

1. Prepare a word statement of the problem.
2. Determine the initial specifications (factors and limitations).
3. Investigate the problem.
4. Modify the initial specifications.

In contrast to textbook problems, many real-life problems are communicated in some vague or imprecise way. Thus, the first order of business is to study the system involved and develop an adequate statement of the problem. This includes determining such things as the appropriate objectives, the constraints on what can be done, interrelationships between the area to be studied and other areas, possible alternative courses of action, time limits for making a decision, etc. This process of problem definition is a crucial one since it greatly affects how relevant the conclusions of the study will be. It is difficult to extract a "right" answer from the "wrong" problem. Thus, it is imperative that the problem statement be clearly and concisely written, for this statement will be the guide for the remainder of the problem solution. Experience has shown that these ends may be attained if the problem definition is a brief paragraph expressing the background of the problem, the function to be performed by the solution, and the major or limiting factors or assumptions.

This phase in decision-making should be executed with considerable care, and the initial formulation of the problem definition should be continually reexamined in the light of new insights obtained during the later phases.

LIST METHODS OF SOLUTION

After defining the problem, the decision maker must ask, "How am I going to solve this problem?" Phase II, listing the methods of solution, is designed to develop a number of alternate solutions which apparently could succeed. From this list the optimum solution or solutions will be chosen.

Often the investigation during the problem definition will give insight into means for solving the problem, but usually this insight is of limited nature. Then, how can we find possible methods of solution?

It is in this phase of problem solving that the resourcefulness of the decision maker will pay off. Some areas to consider in developing possible solutions include:

1. Books or articles on the subject.
2. Movies, filmstrips, tapes, or other A-V resources.
3. Field trips and interviews with experts.
4. Brainstorming sessions.
5. Laboratory experimentation.
6. Thinking up imaginative new ideas.
7. Analysis of existing data.
8. Building a model.

All eight of the methods listed above are important, but two-brainstorming and modeling--deserve special mention here.

A brainstorming session is a meeting of several (2 - 15) people having as the explicit purpose to suggest as many solutions for a particular problem as possible. The ground rules may be as follows:

1. A brainstorming session leader should be selected from the group. Usually he is the person who has called the session. The leader's responsibilities are:
    a. to stimulate and record suggestions for solving the problem. The session should be enthusiastic and lively.
    b. to keep the group working on the defined problem.
    c. to direct the group so that the proposed solutions have a realistic basis.
    d. to stimulate the groups' thinking and prevent random solutions.
    e. to stop criticism on any of the suggested solutions.
2. Each group member should relate anything and everything that he feels might effect a solution to the problem regardless of how unusual it may sound.
3. No criticism or evaluation of any idea submitted as a possible solution is permitted. It is easy to criticize but hard to create. Save the criticism until later.
4. The ideas suggested should be recorded by brief statements in a place where all of the group can see them.
5. The brainstorm group should not be interrupted or distracted once the brainstorm is in session.

What actually transpires in a brainstorm session is described below. Each of the participants come to the meeting aware that they are not going to be ridiculed, laughed at, or held accountable for anything they say.

Consequently, they lower the barriers of the meticulously precise person and just let the ideas fly. Perhaps one person comes into the meeting with only two or three thoughts as a means for a solution.

Hearing the suggestions of the group triggers off new concepts in his mind and the same is true for the other participants. It is important to keep all critical thinking out of the session. For just one question such as, "Why will that idea work?" can shift everyones attention from the development of new ideas to the evaluation of those suggested. The brainstorm session will come to a halt as a result of this.

A brainstorm session should not include just students or experts on the subject, but it should have people with a good diversity of backgrounds. This will help in producing a variety of suggestions.

One might get the impression from the above paragraphs that personal brainstorm sessions should not be held or are not fruitful. This is not the case at all. They are definitely helpful and are recommended. Their purpose is not the stimulation of other peoples ideas, which is a prime purpose of the group brainstorm, but rather to "turn off" a person's critical thinking and let all the ideas come forth.

The results of a group brainstorm session can be phenomenal. It is not infrequent to get one hundred ideas in a 45 minute session from a group of 15 people. If the group leader wishes to expand or modify the ideas presented, or stimulate the group's thinking further, he can ask a series of questions similar to those below about each idea or suggested method of solution.

1. How could this idea be changed?
2. What else could be done?
3. What aspects could be changed?
4. How about interchanging two parts of the solution?
5. How can we do this differently?
6. Could it be done cheaper?

7. What is this idea similar to?
8. Suppose we split this up?
9. What possible combinations could be utilized?
10. What likeness and differences should be analyzed?
11. What happens before or after?
12. What if the order were changed?
13. How else chould this be arranged?
14. Why does it have to be done this way?

An important aspect in solving problems is their rearrangement into a form that is suitable for study. One method of doing this is to construct a model that represents the essence of the problem. Common examples of models are maps, portraits, model airplanes, dolls, etc. Similarly, models play that an important role in science or business include, models of an atom, or a thunderstorm, models of genetic structure, mathematical equations, graphs, chemical equations, organizational charts, or corporation budget and accounting systems.

Models are symbolic representations of "real world" situations. They are used not only to describe a situation or set of ideas, but also to evaluate and to predict the behavior of systems that are not suitable for direct analysis. Examples of such systems are walking on the moon, an urban traffic system, a new airplane design, and an international trade policy. Studying a model can save considerable time and money. it can avoid or minimize expensive failures and permit the best design without the necessity of constructing many versions of the real thing. Models evolve and usually go through a process of successive refinement until a satisfactory model is developed. One can scarcely read a technical journal today without finding some mention of the modeling concept.

Just as there are numerous types of "real world" situations so too, there are several types of models. A few of these are physical models, abstract models, symbolic models, and mathematical models.

Model airplanes and automobiles are examples of physical models. Scale models may actually resemble a plane or car in general appearance and to some extent in function. The physical model of an aircraft can be studied in a wind tunnel to learn about the flight performance characteristics of a full sized aircraft. It should be noted here that engineers do not rely solely on the model method. One cannot automatically obtain useful information about the original phenomena from the study of a model. Whether a model will be useful or not will have to be determined from experience by comparing performances of the original phenomena and the model.

Models that are used to explain or demonstrate a phenomenon such as an eclipse or the growth of a city are called abstract models. Another abstract model is from the area of meteorology. Here, it is important to understand the behavior of clouds in a hailstorm, and thus it is necessary to develop the model of a thunderstorm. To do this, we need to know items such as where is the air going in and coming out, how extensive and severe are the updrafts and down drafts, how and where does the hail form, how does it grow, and what determines when it falls out of the cloud. All of this information is necessary if we are to build an accurate model of a thunderstorm, and a good model will be required if we are to modify its behavior to reduce the damage caused by hail.

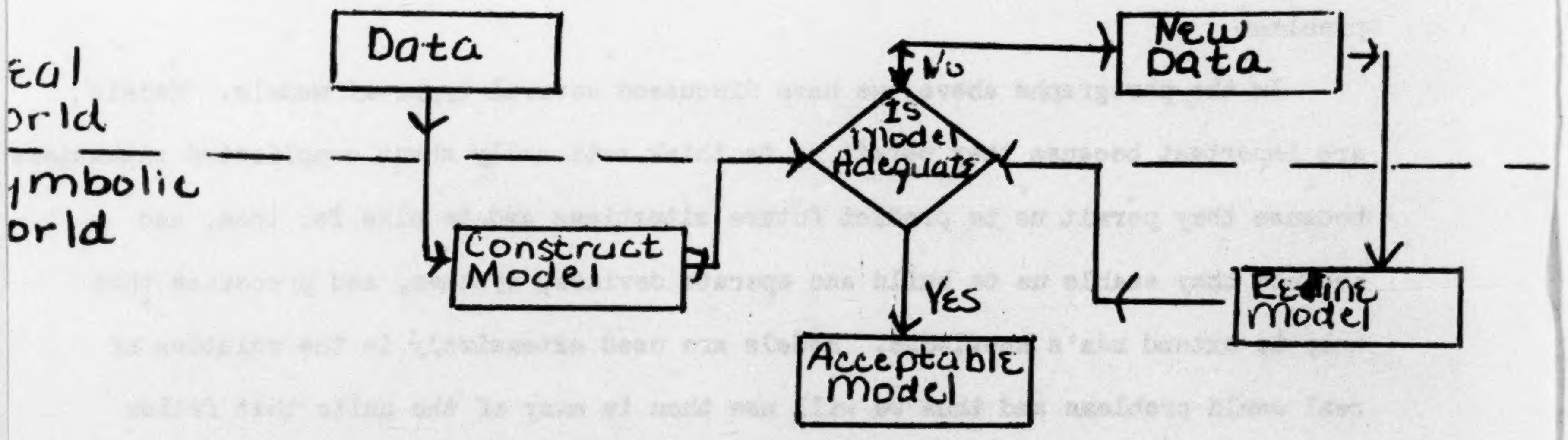
In a symbolic model "real world" items are represented by symbols or concepts. Your bank account is a symbolic model of a portion of the money you own. The numbers on your check stubs represent the amount of money you have, while the checks you write are themselves symbolic of a transfer of funds from your account.

Mathematical models are representations expressed in terms of mathematical symbols and expressions. The laws of physics such as $F = MA$ and $E = Mc^2$ are familiar examples. Mathematical models describe a situation very concisely. This tends to make the analysis of the problem more convenient and comprehensible. It oftens forms the bridge that is necessary if we are to employ high powered mathematical procedures or electronic computers to aid in the solution of a problem.

In the paragraphs above, we have discussed several types of models. Models are important because they permit us to think rationally about complicated situations because they permit us to predict future situations and to plan for them, and because they enable us to build and operate devices, systems, and processes that help to extend man's knowledge. Models are used extensively in the solution of real world problems and thus we will use them in many of the units that follow in this course. In the Geography and Internation Simulation Unit, you will build models of several mythical nations, and a mathematical model describing the relationships between nations will be utilized to determine the characteristics of each nation after important decisions have been made. In the Environmental Crises Unit a population growth model must be developed if we are to adequately understand the long range effect of the population explosion. In the final unit, The Year 2,000, we will build a model to help us visualize what life in the USA might be like in the future. Since we will be using this concept often, we should consider briefly the essential parts of the model making process.

Measurements or observations of the real world are collected and this data used to construct the initial model. In the creation and utilization of models there are two lines of development--one in the symbolic world and the other in the real world. (See figure on the next page).

After the initial model is completed, measurements and predictions are made with it and these evaluated against or compared to the behavior of the system in the real world. In cases where this evaluation shows that the model is inadequate, new data are collected, and the model refined. This process is repeated until the evaluation indicates that the model is acceptable. The process is then considered complete.



The Model Making Process

INVESTIGATE AND EVALUATE EACH METHOD

During the search and listing of methods the critical analysis and judgement of ideas were not permitted since they tend to inhibit the production of new ideas. However, after the ideas and methods have been determined the decision maker will want an investigation an an appraisal of each method, its value as potential means for solving his problem. For most of us, this is probably the easiest phase in the decision making process, for being critical comes natural.

After listing possible methods of solution, the problem solver will want to investigate each one to determine all of the factors involved, any limiting conditions which are present, and the assumptions which must be made. In this part of the study he will be asking questions like: how much does it cost, can it be implemented, how does it work, how big is it, is there enough known about it, and does it involve any unreasonable assumptions. After gathering enough information about each method, the decision maker is ready to evaluate them.

There are two questions involved in the evaluation of a method or the test of a model. They are:

1. What is the standard for our evaluation?
2. How do we compare the method or model to the standard?

The standard for our evaluation can be but one thing: THE PROBLEM DEFINITION which we stated in Phase I. Without an adequate problem definition there cannot be an adequate evaluation. With each method there is a certain expected outcome. During evaluation we consider the desirability of that outcome. Our criterion must be: Select the method with the highest desirability.

Assuming an adequately defined problem, a sound knowledge of the ideas and expected outcomes, how should we organize to effect a comparison? It is a good idea to divide the comparison into two parts; (1) the preliminary comparison and (2) the detailed comparison. During the preliminary comparison attention is paid to gross or overall considerations. Several specific items that might be part of a preliminary comparison are:

1. Is the problem really solved or is it just discussed?
2. Does the idea or method solve only part of the problem?
3. Is the proposed solution practical?
4. Have all the important items or aspects of the problem been considered?
5. Is the proposed solution too elaborate?
6. In the proposed solution are there any known laws or principles that have been violated?

In this comparison the problem solver must determine if the idea or method has any major or radical deviations from the problem definition.

The detailed comparison is reserved for those ideas which successfully pass the preliminary test. During this comparison the idea or method is "given the works." Typical items to consider under the detailed comparison are:

1. Can it be clearly shown that the idea will solve the problem?
2. Is the proposed solution reliable and does it have a high degree of desirability?
3. Can the proposed solution be implemented?
4. What will be the reaction of those specifically involved to the proposed method or idea?
5. How is the proposed solution better than the method presently in use?

It should be clear that all the items mentioned above will not apply to all problems. They should rather suggest a general approach that can be used on all problems. After utilizing the foregoing procedure, the decision maker should be able to state that a method or idea is either satisfactory or not and that it has a certain degree of desirability.

It is possible that by the time a problem solver has reached the end of the evaluation phase of the decision-making process he will have learned enough new facts to alter the problem definition. If this is true, he should by all means do so. For remember he must at all times work with an "adequate problem defintion."

SELECTION AND IMPLEMENTION OF METHOD

In selecting the method or methods to solve the problem, additional information or data should not be necessary. Sufficient information should be available from the previous evaluations. What is needed in this phase is a judgement pointing out which method or methods are preferable.

In some types of problems, it is reasonable to search for an "optimal" or the best solution. Network problems, linear programming problems, and queueing problems are examples of the type problem that have one best solution. However, some types of problems do not have a single best solution. Examples are the design of a classroom, writing a computer program, and the development of a mythical nation. Thus, in selecting the method to be implemented, we must be aware of the type of problem with which we are dealing. That is, does it have an optimum solution or not.

If we have a problem that has an optimum solution, the computations must be completed and the best solution will then be obvious to us. However, it should be realized that problems of this type involve a mathematical model and that these solutions are optimal only with respect to the model being used. Since the model necessarily is an idealized rather than an exact representation of the real problem, there cannot be any guarantee that the optimal solution for the model will prove to be the best possible solution that could have been implemented for the real world problem. This is determined by how closely the model represents the real world.

In problems that have more than one "right" answer we must be concerned with the desirability of each of the proposed methods of solution. The problem then really comes down to one of measuring desirability. This is an area that has generally been neglected by those studying decision-making or problem solving. It is not an easy job, but it is one that must be done. You must determine some way of measuring the degree of desirability for each individual problem. Perhaps it can be expressed in monotary terms or time saved, or the approach that is most pleasing.

Admittedly this step usually involves the best judgement of the decision maker. Our procedure, after we have determined the desirability of each possibility, is to select the method with the highest desirability. After a decision has been made, it then remains to be implemented and evaluated.

The implementation part of this phase is an important one, for it is here and only here that the benefits of the study are reaped. It is important that the decision maker is certain that his proposed solution is accurately translated into operating procedure. The success of the implementation phase usually depends to a great extent upon cooperation of the people involved. The final phase in the decision-making process is that of evaluation of the results obtained.

TESTING THE RESULTS

The testing and feedback phase must follow implementation of the proposed solution. This is an interesting and important phase for it is here that the problem solver learns how successful he was. There are two questions that the problem solver must answer to complete this phase in the decision-making process. They are:

1. Does the solution as implemented completely solve the original problem?
2. If not, what changes must be made to do so?

The answer to question 1 will be found by comparing the results obtained from the implemented solution with the PROBLEM DEFINITION. If the results safisfy the given problem in all aspects then it will be considered a satisfactory solution and the decision-making process completed. If there is one or more aspects of the original problem which are not completely solved then the initial problem must be redefined and the problem solving approach restarted at Phase II.

This procedure is followed until a satisfactory solution is obtained.

CONCLUSION

In concluding this discussion on decision-making, it should be emphasized that there may be exceptions to the "rules" or "procedures" outlined above. By its very nature decision-making or problem solving requires considerable ingenuity and innovation and it is not possible to write down any one correct set of procedures that will solve all types of problems. Rather the description given above should be considered as a "model" that roughly represents how successful decisions can be.

PROBLEM SOLVING APPROACH
A SUMMARY

I. Define the problem

- a. Word statement
- b. Initial specifications
- c. Preliminary investigation and modification of initial specifications

→ II. List methods of solution
Consider each of the following:

- a. Previously published material in problem area
- b. Field trips and interviews with experts
- c. Brainstorming session
- d. Build a model
- e. Conduct experimentation
- f. Resourceful thinking

Redefine Problem

III. Investigation and evaluation of methods

- a. Compare proposed schemes with problem definition
    1. preliminary comparison
    2. detailed comparison

IV. Select and apply best method

1. optimum solution
2. most desirable solution

V. Test the results

- a. does solution satisfy problem definition
- b. what changes must be made

CHECK LIST FOR A PROBLEM STUDY

After a problem has been solved, a report is prepared. After this report is organized, it should be checked before placing it in final form. Questions which might be asked in checking are:

I. SUBJECT

_____ 1. Is the subject clear and concise?

_____ 2. Does it indicate the nature of the study?

II. PROBLEM

_____ 1. Is the problem statement clear and complete?

_____ 2. Is the study limited to a specific, manageable problem?

_____ 3. Is the statement of the problem free of extraneous material?

III. FACTORS BEARING ON THE PROBLEM

_____ 1. Have all of the constraints been identified?

_____ 2. Are the facts presented pertinent, acceptable, and authoritative?

_____ 3. Are assumptions indicated and are they logical and acceptable?

_____ 4. Are facts distinguished from assumptions?

_____ 5. Are the factors necessary to evaluate all possible solutions included?

_____ 6. Are necessary terms defined?

_____ 7. Have the possible methods of solution been identified?

IV. DISCUSSION

_____ 1. Is the discussion pertinent and concise? Does it contain unnecessary material?

_____ 2. Is the discussion developed so that a logical flow of the thoughts is maintained?

CHECK LIST FOR A PROBLEM STUDY (cont.)

IV. DISCUSSION (cont.)

_____ 3. Are all important solutions included in the discussion?

_____ 4. Are possible solutions adequately evaluated?

_____ 5. Has the best possible solution (or solutions) been clearly identified?

_____ 6. Have the necessary tables, charts, graphs, and data been included to support claims?

V. CONCLUSIONS

_____ 1. Do the conclusions completely satisfy the requirements of the problem?

_____ 2. Do the conclusions state briefly the best solution or solutions?

_____ 3. Does this section contain only material belonging in it? It should not continue the discussion or introduce new material.

VI. RECOMMENDATIONS

_____ 1. Are the recommendations clearly and logically supported by the rest of the study?

_____ 2. Are the recommendations the most suitable, feasible, and acceptable courses of action?

_____ 3. Would you be willing to stake your reputation on the actions you recommended? Can YOU stand behind them?

_____ 4. Have all of the instructions or directions necessary for implementing the recommendations been included?

WRITING TECHNIQUES

_____ 1. Is the material well organized, concise, and does it follow the prescribed form?

_____ 2. Is each paragraph concerned with one topic or one phase of the topic?

_____ 3. Is there smooth transition from one paragraph to another?

_____ 4. Are sentences clear and logical?

CHECK LIST FOR A PROBLEM STUDY (cont.)

WRITING TECHNIQUES (cont.)

____ 5. Are sentences free of involved and awkward construction?

____ 6. Is the language free of verbiage and jargon?

PRESCRIBED FORM

____ 1. Is the report in the form requested?

TEAM NAME OR PROBLEM NUMBER

ABSTRACT (Tells briefly what the report is about. It usually summarizes the conclusions and recommendations, and is normally limited to approximately 100 words.)

SUBJECT (Only long enough for identification of topic.)

PROBLEM (Clear statement of what you are solving.)

FACTORS BEARING ON THE PROBLEM (Factors limiting or otherwise influencing the problem, including pertinent facts and basic assumptions.)

DISCUSSION (An objective, critical analysis of the factors involved.)

CONCLUSIONS (Judgments which are a logical outgrowth of the DISCUSSION)

RECOMMENDATIONS (Clear indication of what is necessary to translate solution in action.)

APPENDICES (A compliation of long tables, charts, calculations, or proofs which support the discussion.)

SIGNATURES OF TEAM MEMBERS

PROBLEMS

Solve each of the following problems using the five phase decision-making procedure outlined previously. Your writing should include:

1. A clear definition of the problem. Be sure to list assumptions and factors involved.
2. A list of the possible solutions.
3. A brief discussion and evaluation of each possible solution.
4. An indication of the proposed solution and why it was selected as the best alternative.
5. A comparison of the results accomplished and the problem definition.

1. a) You are on a double date and must decide where to eat after the movie.

   b) How will your approach be changed if you were to decide where your family should eat out next Sunday?

2. You have been given $15 and plan to buy a new pair of shoes. Outline the procedure you will go through.

3. You are to buy a second car for a family of four. They already have a 1967 Chevrolet stationwagon. The wife will be the primary driver of the second car. The family has allocated $750 to cover all the expenses for the second car and they want this car to be as reliable and economical as possible. There will be no trade in and the car will be paid for in cash. What model and make of car should they select?

4. Eight people are stranded on an island. They have plenty of food and water. There are enough materials on the island for shelters. A rescue plane can take only two persons from the island and the plane can never return. No ships could ever find the island. Of the following eight people, who should be allowed to go on the plane?

   Catholic Priest

   Vice President of the United States

   Diabetic old man

   Teenage girl

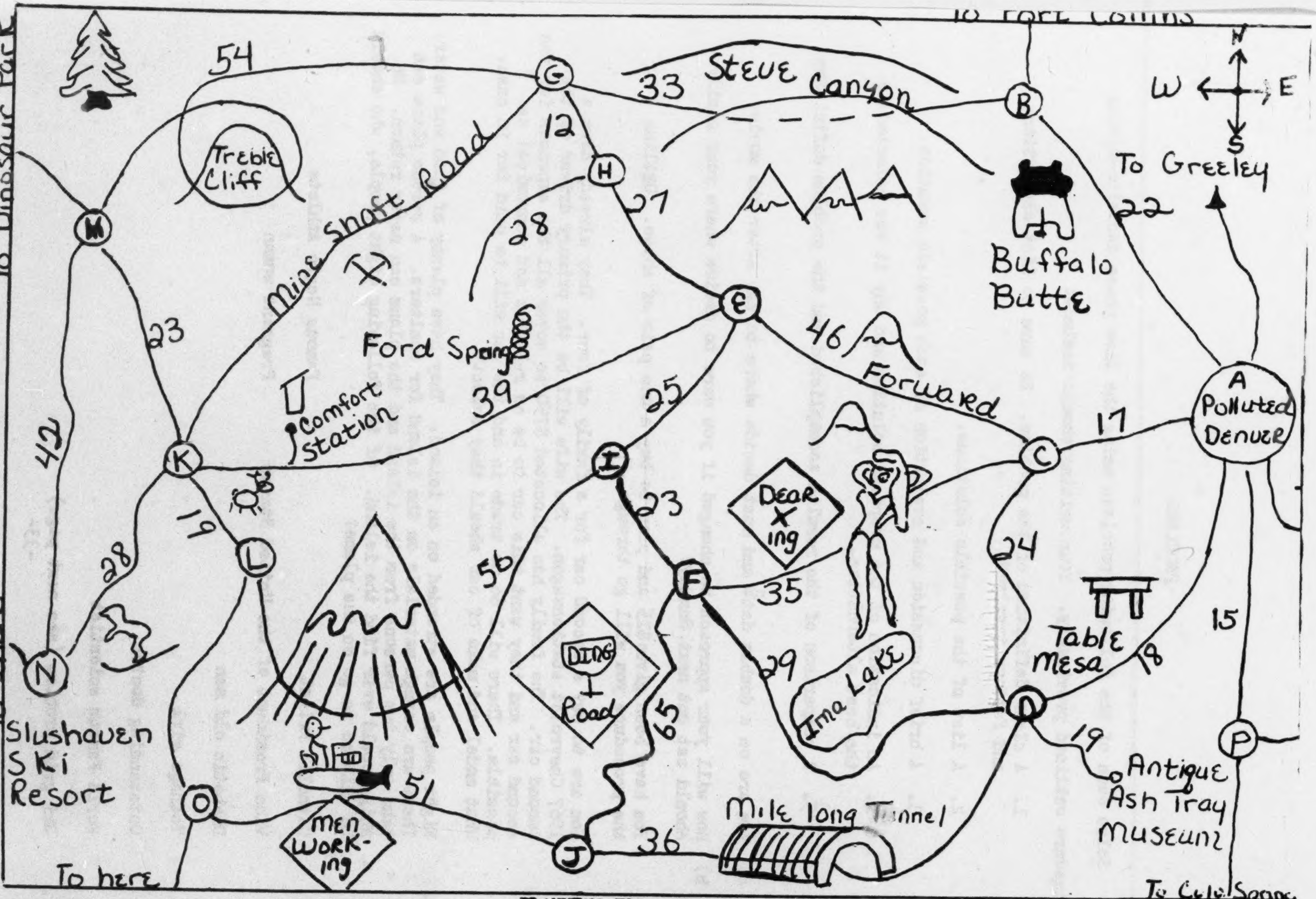
   Outstanding doctor

   World Famous scientist

   Famous Negro Athlete

   Pregnant woman

5. Ski grid problem (see next page)


To Fort Collins
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To Greeley
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Buffalo Butte
Steve Canyon
33
G
54
To Dinosaur Park
Treble Cliff
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Mine Shaft Road
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Forward
Ford Springs
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Comfort Station
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23
25
Dear X ing
35
29
Ima Lake
C
17
A Polluted Denver
24
Table Mesa
18
D
19
Antique Ash Tray Museum
15
P
To Colo Springs

PLANNING FOR A SHORTENED DAY

A group of students plan to spend a day at the Slushaven Ski Resort. They plan to leave Denver at 6:00 a.m. in the morning and drive to the resort. Since their main interest is skiing, they desire to reach the resort by the fastest possible route. There are several routes available to them, and picking the best one from a map is not easy. Use your knowledge and average driving times (in minutes) between intersections indicated on the above map to find the fastest possible route.

Minimum time = ________ Minutes

PROBLEMS (cont.)

6. Your school administration is faced with an increased enrollment problem and have decided to add additional classrooms to the existing building. You are asked to design a cluster of five classrooms. The principal has advised you that anything is okay (in fact he wants you to be creative in your thinking) provided it is educationally sound and that the cost to build and equip the cluster does not exceed $50,000. Please include in your report a drawing showing the design and include a discussion of the factors involved.
7. Land Pollution (see next page)
8. School scheduling problem.

LAND POLLUTION[1]

Introduction

Abatement of land pollution and the provision for adequate solid waste disposal facilities is a critical problem for most communities in the state of Colorado. Increases in our population and the affluence of our society have resulted in the production of ever larger quantities of material to be discarded, and lessened our desire to conserve and restore these materials. Urbanization, in turn, has increased the problems associated with transportation and disposal of these solid wastes by concentrating the production of solid waste and eliminating the open space which has traditionally been utilized in disposing of these wastes.

Solid waste, or refuse, is a mixture of garbage, trash, and scrap materials that accumulate in the household, business, and industry at the rate of about four and a half pounds each day for every person residing in a community. Generally, the volume composition of mixed refuse is 60% paper and rag, 10% grass, 10% metal, 10% glass, 5% ashes, and 5% garbage. Although the food preparation discards or garbage fraction is relatively small, it takes on major emphasis due to its odor potential, its role as a food source for insects and rodents, and the effects associated with the bacterial decomposition of this fraction such as volume change, burnable gas production, and groundwater pollution potential.

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[1] An Urban Environment problem developed by the Dept. of Chemical Engineering and Dept. of Civil Engineering at the University of Colorado, Boulder, Colorado, for use at the High School Honors Institute, August 17 - 20, 1969.

For each community the problem of solid wastes management involves establishing the most economical, safe, and nuisance free method of eliminating from its immediate environment, a large amount of domestic wastes, as well as industrial wastes, sewage, sludge, car bodies, and construction discards. This system must be designed and operated to prevent air and water pollution as well as land pollution. Three methods of treatment and disposal are currently practiced in providing a solution to the problem: central incineration, sanitary landfill, and composting.

Boulder County Solid Waste Management

The solid wastes produced by the communities within Boulder County are currently disposed of at a number of small facilities throughout the county. The effectiveness of these operations varies from site to site as will be illustrated by visits to two of the disposal sites. The overall effect of the current program suggests inadequate management of our wastes. The problems associated with management of these small, local facilities stem in large part from the limitations imposed by economic considerations.

The aim of the current study will be to develop a program of solid waste management for disposing of the refuse from the communities within Boulder County. This will include a recommendation of the number and type of facilities to be used as well as their location.

LAND POLLUTION PROBLEM

DATA

A. **Rate of solid waste production**

5 lbs./capita/day at a packed compacted reuse density of 450 lb./yd.^{3}

Annual per capita increase in production is 2½%

B. **Haul Cost**

Transportation of refuse with a 20 cu. yd. packer costs approximately $0.15/mile.

C. **Disposal Costs**

1. **Incineration -**

   Operating - $4.50/ton

   Fixed - $1.50/ton

2. **Composting -**

   Operating - $3.50/ton

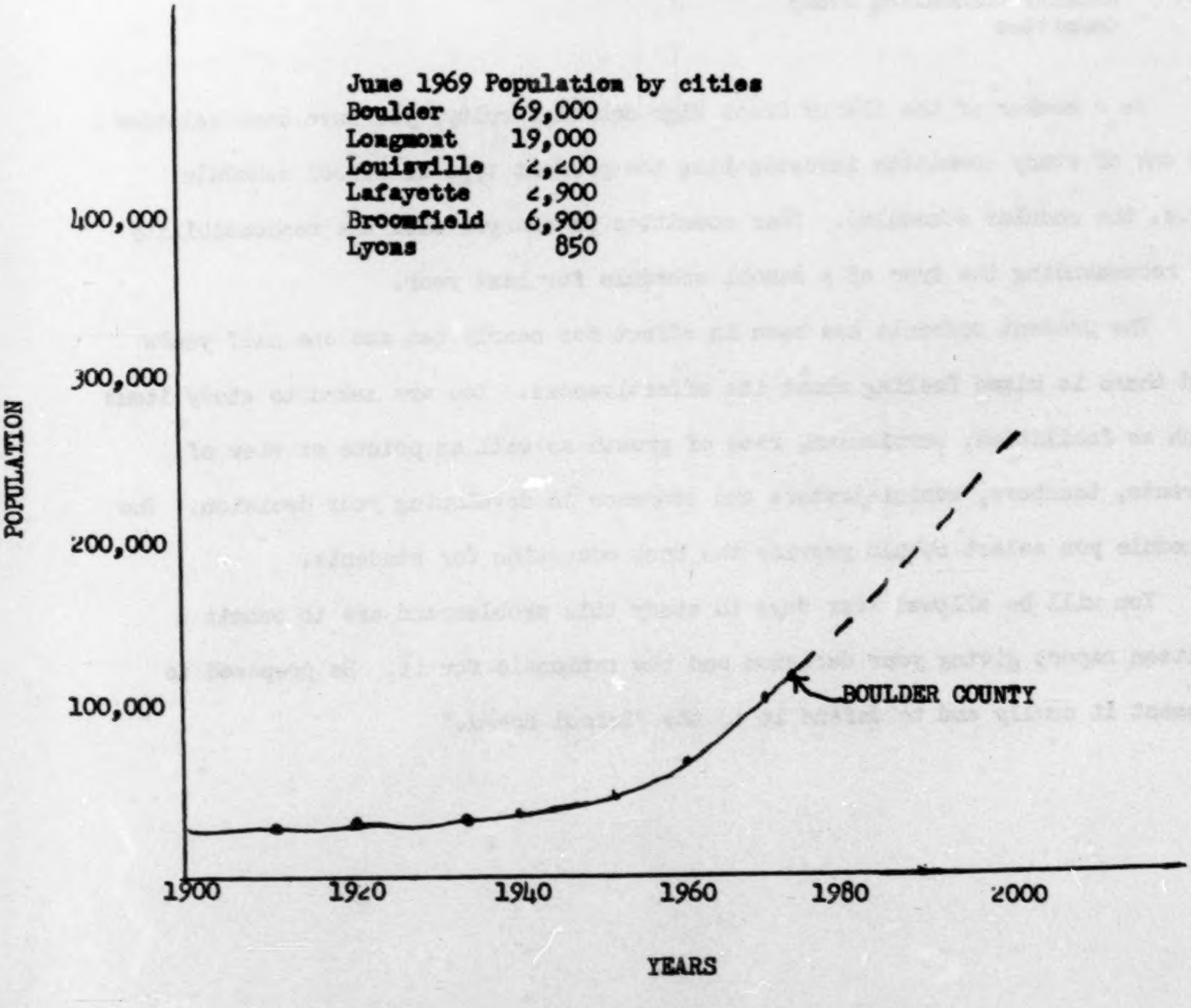
   Fixed - $1.00/ton

3. **Sanitary Landfill -**

   Operating - $1.25/ton

   Fixed - $0.40/ton

BOULDER COUNTY
POPULATION PROJECTION



June 1969 Population by cities	
Boulder	69,000
Longmont	19,000
Louisville	2,200
Lafayette	2,900
Broomfield	6,900
Lyons	850

MEMORANDUM

FROM: Office of the Principal
Cherry Creek High School

TO: Modular Scheduling Study
Committee

As a member of the Cherry Creek High School faculty, you have been selected as one of study committee investigating the present type of school schedule (i.e. the modular schedule). Your committee is charged with the responsibility of recommending the type of a school schedule for next year.

The present schedule has been in effect for nearly two and one half years and there is mixed feeling about its effectiveness. You are asked to study items such as facilities, curriculum, rate of growth as well as points of view of parents, teachers, administrators and students in developing your decision. The schedule you select should provide the best education for students.

You will be allowed four days to study this problem and are to submit a written report giving your decision and the rationale for it. Be prepared to present it orally and to defend it to the "School Board."

9. Glenwood Canyon mining problem, (see bibliography.)

10. The complexity of today's world has not simplified the difficult job of deciding what career a person should consider for his life's work. However, the literature now available to help a person with this decision is plentiful, and with some effort, high quality materials can be found. In addition, many additional resources such as movies, tapes, field trips, and interviews with experts are now readily available. In this problem you are to determine the career that you believe is most appropriate for you. In addition to the five items outlined for the problem writeup, you must interview a person presently employed in this occupation, and if possible visit and observe the person in his owrk for a full day. The results of the interview and observation should be included in your writeup.

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UNIT: COMMUNICATIONS

Objectives:

I. To improve the ability of a group to function together toward a common solution to a given problem in the units studies throughout the year.

II. To improve the preccesses of positive non-verbal communication in the units studies throughout the year.

III. To improve the art of listening in group situations in units studied throughout the year.

IV. To improve the behavior of group processes so that they contribute toward the needs of the group and to the achievement of the groups goals.

V. To understand the necessity for maintaining an unrelenting respect for the dignity and intelligence of the individual and his ideas.

Activities:

I. The students will participate in a three day retreat under the leadership of Carl Hollander, Director of the Evergreen Institute.

II. The students will participate in a continual four hour session of Star Power--a simulation.

III. The students will view the movie, "Z".

Evaluation:

I. The group functioned together toward a common solution to a given problem in the units studies throughout the year.

II. The process of positive non-verbal communication improved in the units studied throughout the year.

III. The art of listening in group situations improved in the units studies throughout the year.

IV. The behavior of the group processes contributed toward the needs of the group and to the achievement of the groups goals throughout the year.

V. The student maintained respect for dignity and intelligence of the individual and his ideas.

COMMUNICATIONS--RETREAT

The process of communication is more than just a matter of language, transmission and having something to say.

Communication is also contact and non-verbal exchange between persons and groups. The goal of the retreat is to emphasize the latter.

COMMUNICATIONS--RETREAT

Objectives:

I. To provide for experiences which lead to effective interpersonal communication.

II. To provide for social interaction which leads to intelligent, constructive solutions to problems.

III. To provide for experiences which improve the art of listening.

IV. To improve the students' security in interpersonal relations.

V. To create an atmosphere of trust.

VI. To develop self-awareness.

VII. To develop self-acceptance.

VIII. To develop peer respect.

Activity:

The students will participate in a three day retreat at Camp Laforet in the Black Forest, Colorado Springs. The retreat will be lead by Carl Hollander, Director, Evergreen Institute for Human Development and Family Growth.

The retreat is geared to the individual and his value as a human being. "Psychodrama, sociodrama, communication exercises, body awareness techniques, and roleplaying will be the methods employed in order to create a climate of emotional honesty and trust where group participents can penetrate their traditional roles in life and experience more direct communication with themselves and others." (Evergreen Institute)

Evaluation:

I. Interpersonal communication is more effective.

II. Social interaction leads to more intelligent, constructive solutions to problems.

Evaluation:

III. The art of listening is improved.

IV. Student gained security in interpersonal relations.

V. An atmosphere of trust prevailed.

VI. The student developed self-awareness.

VII. The student developed self-acceptance.

VIII. The student displayed respect for his peers and their ideas.

STAR POWER

R. Garry Shirts

This is a game in which a low mobility three-tiered society is built through the distribution of wealth in the form of chips. Participants have a chance to progress from one level of society to another by acquiring wealth through trading with other participants. Once the society is established, the group with the most wealth is given the right to make the rules for the game. They generally make rules which the other groups consider to be unfair, fascistic and racist. A revolt against the rules and the rule-makers generally ensues. When this occurs the game is ended. The game is useful for raising questions about the uses of power in a competitive society.

Preparing for the Game

Dividing the Participants and Assigning Chips

The participants are divided into three approximately equal groups named: squares, circles, and triangles. Each person wears a symbol representing his group, i.e., the squares wear a square symbol, the circles a circular symbol and the triangles a triangular symbol.

Each participant is given five chips. Each square receives one gold chip, one green chip and the remaining three randomly selected from the colors red, white and blue. Each circle is given one green chip and the remaining four selected from the colors red, white and blue. The triangles are given a random assortment of red, white and blue chips. The only exception to this distribution is that one circle and one triangle receive the same distribution as the squares, i.e., one gold, one green and a random assortment of red, white and blue.

Determining the Chips Required for a Game

The TOTAL number of chips required equals:
5 X number of participants

The number of GOLD chips required equals:
The number of squares plus 2

Determining the Chips Required for a Game (cont.)

The number of GREEN chips required equals:
The number of squares plus the number of circles plus 1

The number of RED, WHITE, and BLUE chips required equals:
5 X number of participants minus the total number of green and gold chips required. There should be about an equal number of red, white and blue chips.

Example: Suppose you have 34 people and divide them into 12 squares, 12 circles and 10 triangles. The total number of chips required equals: 5 X 34 or 170. The total number of GOLD chips required equals: 12 (the number of squares) plus 2 or 14. The total number of GREEN chips required equals: 12 (the number of squares) plus 12 (the number of circles) plus 1 or 25. The total number of RED, WHITE, and BLUE chips required equals: 170 - (14 plus 25) or 131 which means about 44 of each color.

Explaining the Rules

1. Tell the participants that this is a game that involves trading and bargaining and that the three persons with the highest scores will be declared the winner. They will probably ask later in the game if there is going to be a group winner. The answer is: "The three individuals with the highest scores will be declared the winners. Do not tell them that a group is going to be given the right to make the rules for the game.

2. Explain the following scoring system to the participants
Every gold chip is worth 50 points
Every green chip is worth 25 points
Every red chip is worth 15 points
Every white chip is worth 10 points
Every blue chip is worth 5 points

Additional points are given if a person is able to get several points of the same color.
Five chips of the same color are worth 20 points
Four chips of the same color are worth 10 points
Three chips of the same color are worth 5 points
No extra points given for two chips of the same color

Example: A person's total score if he had 5 gold chips would be 250 plus 20 for 5 chips of the same color for a total of 270 points. If he had four blue chips and one red chip, his score would be equal.

Example (cont.):

4 X 5 (for the blue chips) plus 15 (for the red chip) plus 10 points for distribution of the same color for a total of 45 points. Three reds and two blues would equal 45 + 5 + 10 or 60 points. Five reds: 75 + 20 or 95 points.

3. Distribute the chips as outlined previously to the squares, circles and triangles.

4. Explain the following rules of bargaining.
   a. They have ten minutes to improve their scores.
   b. They improve their scores by trading advantageously with other squares, circles and triangles.
   c. Persons must be holding hands to effect a trade.
   d. Only one for one trades are legal. Two for one or any other combinations are illegal.
   e. Once participants touch the hand of another participant a chip of unequal value or color must be traded. If a couple cannot consummate a trade they may have to hold hands for the entire ten minute trading session.
   f. There is no talking unless hands are touching. This Rule Should Be Strictly Enforced.
   g. Persons with folded arms do not have to trade with other persons.
   h. All chips should be hidden. This Rule Should Be Strictly Enforced.
   i. Do not reveal that the squares are given chips of a higher value than the circles or triangles.
   j. Any other rules that you deem appropriate.

Start the Trading Session

1. After the rules have been explained, start the trading session. Tell them it will last 10 minutes.

2. During the trading session, your assistant should be putting each participant's initials on the blackboard.

3. After 10 minutes of trading session, have each group return to their circle of chairs.

4. Have the participants compute their scores for the trading session, record them on their score sheet and hand the score sheet to your assistant.

5. Have your assistant record the scores on the blackboard opposite the persons initials. (The initials and their scores can be put on by the participants themselves if an assistant is not available.)

Start the Trading Session (cont.)

6. Explain the rules for the bonus points session. The rules are:
   - a. Hold up a bonus chip (a double chip) and tell them that this is a bonus point chip.
   - b. Give each group three chips.
   - c. Tell them that each chip is worth 20 points.
   - d. Their task during the bonus session is to distribute the bonus chips to members of their group.
   - e. The chips must be distributed in units of 20 or more, that is, one person might receive all 3 bonus chips and 60 points or 3 people might receive 1 chip each worth 20 points, but 6 people could not receive 10 points each.
   - f. They have five minutes to distribute the bonus chips. If the groups has not distributed the chips at the end of the five minutes, the points will be taken back by the director and no one will receive them.
   - g. The decision regarding the distribution of chips must be unanimous vote.
   - h. Participants can eliminate people from their group by a majority vote. (Eliminated people can form another group.) They should be a triangle group.

7. Answer any questions.

8. Start the bonus chip bargaining session.

9. After about five or ten minutes, end the bonus chip bargaining session.

10. Have those people who receive bonus points record them on the blackboard oppositive their initials.

11. Put those people with the highest total scores in the square groups. If there is a circle or a triangle who has a higher score than a square, have them trade groups. Any changes should be announced to the group and it generally made known that so and so who was a square has become a circle, because they did not receive enough points, and so and so who was a circle, is now a square because they received a higher number of points than a square. In any event, it is important that the group know that the squares are made up of those people with the highest scores.

12. Start the second round.

NOTE: Repeat this cycle--bargaining session, bonus session, reclassification for one or two times or until the participants understand the process and the fact that the squares are high scorers.

Start the Trading Session (cont.)

13. After about the second bonus session, announce that the squares now have the authority to make the rules for the game and that while any group can suggest rules for the game the squares will decide which rules will be implemented. You might tell the squares that they might want to make rules like: re-distribute the chips on a more equal basis, require triangles and circles to bargain with the squares even though they have their arms folded, require triangles and circles to give squares the chips they ask for regardless of whether they want to trade or not, etc. Announce any rules that the squares establish to all of the participants unless they want them kept a secret.

14. From then on, play it by ear.

What is likely to happen is that the squares will make very tough, rules that protect their own power. This has happened in every organized group that we have played it with so far. The circles and triangles will either give up, organize, become hostile, or commit an act of frustration and defiance. Stop the game when it is evident that the squares have made rules which the others consider unfair and fascistic. This is generally after two to four rounds. After the game gather the group together and discuss the implications of the game for the real world.

Some questions you might want to discuss at the end of the game.

a. Are there any parallels between the system set up by the game and the system or subsystems in which we live?
b. Does the game say anything about the nature of man?
c. Is it the nature of man to seek inequality? To attempt to be better than his fellow man, to seek for more privileges and wealth? If yes, is there anything wrong with such strivings. Can they be legitimatized? Is there a moral alternative to man's search for inequality?
d. Would it have made much difference if the people who were the circles had been the squares?
e. Were the squares acting with legitimate authority?
f. Are there any parallels between the game and the race problem, the campus problems, the problems faced by our founding fathers?
g. If an entire groups acts in unison such as the circles and triangles frequently do in going against the squares, does their actions have more legitimacy than when a person acts alone?
h. Is the square a masculine or feminine symbol?
i. Would it be possible to develop a game which emphasizes cooperative behavior and is fun to play?

Summary of Rules for Running Star Power

1. Prepare distribution of chips.
2. Divide participants into three groups.

Summary of Rules for Running Star Power (cont.)

3. Distribute symbols to appropriate groups.
4. Distribute chips.
5. Explain rules for trading session.
6. Have the group trade for 10 minutes or so.
7. After ten or so minutes stop trading session and have the participants return to their original group.
8. Have them record scores on slips.
9. Give three bonus chips to each group.
10. Explain rules for bonus chips to each group.
11. Give the participants five to ten minutes for bonus chip session.
12. While they are in bonus group session collect all the chips originally distributed and prepare them for the second round of distribution.
13. End bonus chip session.
14. Revise the scores on the board to reflect points received from the bonus chips.
15. Promote high scoring persons to squares and demote low scoring squares to circles or triangles.
    END OF THE FIRST ROUND
16. Repeat process.
17. After second or third round give rights to make rules for the game to the squares.
18. Play it by the nose from then on.

One note of caution. Generally groups need to talk about the game in personal terms or, "who did what to whom" before going on to the issues involved. This can be an important experience in interpersonal relationships, helping members of the group understand their reaction to authority, competitive situations, etc. However, it is important that this discussion does not damage the ego, status or self-concept of any of the participants. If, you see the discussion going beyond the point of friendly rivalry, then you might direct it more forcibly toward the issues involved rather than the personalities. If in the unlikely event that the squares are being badly scapegoated than you might point out that every group that has participated in the game thus far has reacted in essentially the same manner and in general try to direct the discussion toward the question of whether any group put in such a situation would act any differently.

UNIT: COMMUNICATIONS (cont.)

Evaluation: I. The simulation provided an experience in interpersonal relationships.

II. The simulation provided interaction with different social classes as well as interaction within a given social class.

III. The simulation provided an insight into the nature of man in a competitive situation.

IV. The strength of a group act as compared to the strength of an individual who acts alone was understood.

V. Questions concerning the rises of power in a competitive society were raised.

COMMUNICATIONS--POWER STRUGGLE

Objectives: I. To understand what may occur in a society considered to be unfair, fascistic and racists when a revolt against the rules and rule-makers ensues.

II. To understand that unlike the Star Power Simulation, the game "Society" does not end when a revolt ensues.

Activity: The students will see the movie "Z" about the revolt in Greece.

Evaluation: I. The student understands what occurred in Greece when a revolt against the government ensued.

II. The students understand that the society involved in the Greek revolt did not end, but was suppressed.

UNIT: NATION BUILDING--INTERNATION SIMULATION

Objectives:

I. The student will help to build or create the elements of which a nation is composed.

II. The student will make decisions as to the type of nation he desires to create.

III. The student will make decisions as to how his nation will inter-act with other nations.

IV. The student will analyze and evaluate the consequences of his decisions as the decisions effect the model of his nation.

Activities:

I. The student will engage in research in order to build his nation.

II. The student will write a paper describing the nation which has been built.

III. The student will develop maps, graphs, and displays to illustrate his nation.

IV. The student will complete the forms necessary to the inter-nation simulation phase.

V. The student will input relevant data into a computer.

VI. The student will analyze and modify his decisions as they effect his nation.

Evaluation:

I. The student did the research necessary to the completion of the unit.

II. The student wrote a paper describing his nation.

III. The student prepared the maps, graphs, and displays.

IV. The student completed the necessary forms.

V. The student was able to input the data into the computer.

NATION-BUILDING UNIT

In this unit, students will work with teachers to develop an understanding of the factors involved in living in and operating a nation. The unit is divided into two phases. In the first phase, the students will build or create a nation according to the constraints and directions given later in this manual. In the second phase, the nations which have been created will interact in the ways in which the students believe nations interact in the real world. For example, nations may develop military alliances, trade agreements, etc. Once decisions have been made students will be able to analyze the consequences of these decisions and to modify future decisions.

Phase I--Nation Building:

I. Students will be assigned to a nation-team. Each team will consist of 5 - 8 students. Each team will be told that it is its responsibility to build or develop a nation. The given factors in this exercise will be:

   A. Geographic size and location.
   B. Decisions will be constrained by geographical size and location in relation to the countries in the real world. E.g.--A mythical nation located in the Middle East cannot have an arctic climate.
   C. Decisions must reflect internal logical consistency.

II. In developing the profile-characteristics of each nation the following elements should be built:

   A. Size of population.
   B. Composition of population--race, age distribution, religion, etc.
   C. Type and quantity of natural resources.
   D. Economic structure--export vs. import, major goods and services.

Phase I--Nation Building (cont.):

E. Allocation of GNP.
F. Type of government - satisfaction with system.
G. What are the geographic features?
H. What is the standard of living?
I. What is the constitutional and legal structure?

III. Students may work on related projects similar to the following:

A. Build maps.
B. World's Fair type of display showing products, customs, etc.
C. A "collage" showing how people live.
D. Graphs illustrating such things as age distribution, projected growth of population and/or GNP, import-export statistics.

IV. Illustrated example of given geographical size and location.

Phase II--Inter-Nation Simulation Game:

I. **Activities**

A. Student, teacher briefing to

1. teach students how to complete the required forms for the game.
2. explain terminology, such as GNP, military allocation, etc.
3. show importance and necessity for international relations.
4. show how computations required in the game are made.
5. explain the latitude and effect of each decision.

Phase II--Inter-Nation Simulation Game:

I. Activities (cont.)

6. explain composition and organization of teams and other organizations.
7. explain the function of the International Organization, and the newspaper.

Note: See Appendix A for standardized forms to be utilized.

B. Play the game.

1. teams fill out budget form.
2. computer expert (students from each team) codes the information.
3. all teams turn information to control center.
4. information is double checked at control center.
5. information is fed to computer and the results obtained from the computer.
6. computer output is double checked by control center.
7. output information is handed to each team.
8. control center feeds the newspaper some information.
9. teams decide on trade, alliances and treaties, and relationships with the International Organization.
10. teams proceed as above in steps 1 thru 9 until termination.

C. Debriefing.

1. Student feedback sessions.

   a. To provide an opportunity for students to question other students about decisions, results, etc.
   b. To provide an opportunity for students to interact about their own feelings in their particular role.

2. Evaluation.

   a. Student diary on what he did and what he felt about it.
   b. Student evaluation of other students performance--stress cooperation.
   c. Teacher evaluation of each nation-team. See Appendix B.

Relation Between This Unit And The ECCP Course And Text

It seems that this unit illustrates the following concepts as related to ECCP:

A. Decision-making

B. Modeling

C. Use of Computers

D. Feedback

E. Man-machine interaction

Bibliography

1. "The First New Nation" Lipset, Seymour.
2. "Internation Simulation Kit" SRA.
3. See newer version of above by IBM.
4. "International Relations" Joseph Frankel.

Appendix B

Evaluation Form--Nation Building Unit

I. Team: List names of team members.

II. Consistency

III. Relation to real world

IV. Evidence of research

V. Completeness and organization

VI. Presentation

UNDERSTANDING COMPUTER CONCEPTS

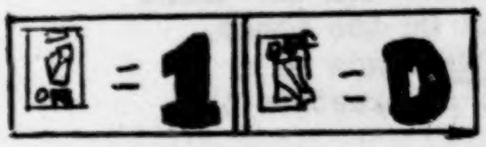
INTRODUCTION

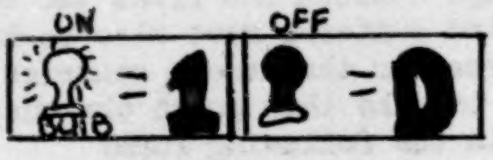
In this unit, attention is focused on the process and techniques by which computers are able to perform the operations which make them one of the most powerful machines invented by man. The concepts associated with computer logic and the electronic circuits which are utilized by computers to solve problems and make decisons will be studied in some detail. During this unit we will learn to program a computer in a language called BASIC. You will actually control a million dollar computer through our remote computer terminal. It is hoped that by this approach you will gain some insight into the power and limitations of the computer.

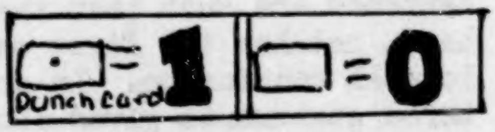
COMPUTER SYMBOLS

Electronic devices respond to electronic signals. To make these signals represent information, we use a code, just as we use a code of sounds with our voice or of written alphabetic letters when we want to communicate in a spoken or written language. As you may know, the modern day computer performs most of its functions using the zeros and ones of the binary code. Using these two symbols many different information codes can be developed and are in fact used in various parts of a computer for handling different kinds of information processing problems.

While the binary code may seem severely limited and quite awkward to those who are used to the decimal system, it is really simplicity itself to the computer. This is because the basic electronic parts inside the computer can exist in only two possible states, current is either on or off, a switch is open or closed, magnetic materials are magnetized in one direction or the opposite. There is no in between those extremes. Some examples of this are given below:







The logical operations used by a digital computer to make decisions as well as other computer functions, are performed using the zeros and ones of the binary system. The basic nature of these functions can best be demonstrated with examples such as we show in the following section.

COMPUTER LOGIC

The logic circuits used in a computer are based upon some very simple concepts. They utilize the same rules of logic used to design home lighting circuits, the rules of Boolean algebra, invented by a nineteenth century English mathematician named George Boole.

A Boolean expression or statement is either true or it is false and those two conditions can be represented by any two state device such as those shown on the first page. Boole devised a set of algebra-like rules for manipulating true-false expressions using three fundamental operations: AND, OR, and NOT.

In studying these three operations it may be helpful to develop some of the fundamental elements of symbolic logic. These ideas will be useful in solving more complicated and sophisticated problems.

THE "AND" FUNCTION

As our first example of a logical operation, consider the following statements:

A. If I go outdoors
and
B. If it is raining
then
C. I will get wet.

Here we have two ideas which combine in a logical way to produce a conclusion which according to the rules we use in our thinking is a true statement.

In order to convey the basic characteristics of this combination of ideas to the computer, we must find a way to represent the basic relationships which link the three statements in the example above using a T-F or 1-0 binary code with which the computer is able to work. Before doing this however, let's examine these statements in more detail.

Here are two statements related in such a way that the third statement can be arrived at as a valid conclusion, given the information supplied by the first two statements. To put it another way, if the first two statements are true, then the relationships between the first two sentences and the third sentence are such that the third sentence must also be true. On the other hand, neither the first sentence nor the second sentence ALONE leads to a logical conclusion. In order to make this point obvious, we can restate the three statements given above in the following form:

A. If it is true that I go outdoors
AND
B. If it is true that it is raining
THEN
C. It will be true that I will get wet.

If we ignore B then C is not necessarily true, and similarly if we do not consider statement A.

THE "AND" FUNCTION (cont.)

If we ignore the context of the three statements and look only at the relationships which exist between A, B, and C we can restate the system as follows:

If A is true AND If B is true THEN C is true.

The relationship linking statements A and B with statement C establishes a set of conditions which suggest that C will be true only when statements A and B are both true. It follows from this that:

If A is false
AND
If B is true
THEN
C is false

If A is false
AND
If B is false
THEN
C is false

If A is true
AND
If B is true
THEN
C is true

If A is true
AND
If B is false
THEN
C is false

To relate the content of these logical statements to a binary system, the following symbols are utilized.

T= statement is true

F= statement is not true

A truth table showing all the possible combinations of truth value for the statements A, B, and C is shown below.

A	B	C
F	T	F
T	F	F
F	F	F
T	T	T

This simple combination of two statements and a conclusion demonstrates one of the basic operations which a computer must be able to perform if it is to solve logical problems. This operation is called "AND" and is symbolized with an upside down U. That is $A \cap B$, read A AND B, will be true only when both statement A and statement B are true. Or stated slightly different statement A and statement B must both be true before C is true.

THE "OR" FUNCTION

Just as arithmetic uses several different operations--addition, subtraction, division, multiplication--to solve arithmetic problems, the solution of logical problems similarly involves the use of several different operations. From the study above you are familiar with the first of these operations--The "AND" Function.

THE "OR" FUNCTION (cont.)

A second operation of basic importance is the "OR" function. Just as the AND operation represents the idea of two things both being true, the OR operation represents the idea of either one or both of two things being true.

Again we illustrate with three statements A, B, and C.

A. If I stand in the rain
OR
B. If I stand in the shower
THEN
C. I will get wet.

Logical representation of the relationships between these three statements may be written using the symbol U to mean OR. And the relationships could then be summarized as AUB=C which is read A OR B is the same as C. This means that C has the same truth value as the statement A OR B. Or differently, C is a true statement only if A is true or B is true or both A and B are true statements. A truth table showing all possible combinations of truth value for A and B and the OR operation is shown below.

A	B	AUB
T	T	T
T	F	T
F	T	T
F	F	F

THE "NOT" FUNCTION

The two logical operations discussed so far have each represented a concept which was basic to the development of logical reasoning. The "AND" operation represents the concept of combination. The "OR" operation represents the concept of alternative. Each of these is a binary operation. That is each operation assigns a truth value to every combination of TWO statements. The last operation we will study--The "NOT" Function--represents an equally important, but somewhat different concept. This operation requires only ONE statement and thus is called a unary operation.

The NOT function reverses the truth value of a statement. That is if statement A is true then NOT statement A is false. If statement B is false then NOT B is true. Symbolically the operation NOT is represented with a ~. For example, if a statement is represented by A, then NOT A is written ~A. The truth table for this function is given below.

A	~A
T	F
F	T

"AND" and "OR" and "NOT"

The concepts of AND and OR and NOT can be combined to express somewhat more complicated conditions for a logical problem. You may wish to find out when statements containing various combinations of these operations are true or false. To do this we construct truth tables for all possible combinations. Study the example below.

A. If I go outside
AND
B. If it is raining
OR
C. If I stand under the shower
THEN
D. I will get wet.

We want to find out when D is a true statement.

This combination of relationships may be expressed symbolically as

$$(A \text{ AND } B) \text{ OR } C = D$$
$$(A \cap B) \cup C = D$$

Building the truth table--first columns A, B and $A \cap B$, then C and $(A \cap B) \cup C$.

A	B	$A \cap B$	C	$(A \cap B) \cup C$
T	T	T	T	T
T	T	T	F	T
T	F	F	T	T
T	F	F	F	F
F	T	F	T	T
F	T	F	F	F
F	F	F	T	T
F	F	F	F	F

We see that D will be true in five possible cases for A, B, and C. You should verify for yourself that each is true under your usual reasoning pattern.

Exercises--Problem Set 1

Construct truth tables for each of the following:

1. $A \cap B$
2. $A \cup \sim B$
3. $\sim(A \cap \sim B)$
4. $(A \cap B) \cap C$
5. $A \cap \sim(B \cup C)$

Using truth tables determine which of the following statements are true.

6. $A \cap B = A \cap (A \cup B)$
7. $\sim A \cap \sim B = \sim(A \cup B)$
8. $A \cap \sim(\sim B) = A \cup B$
9. $A \cap (B \cap C) = (A \cap B)\ C$
10. $A \cup (B \cap C) = (A \cup B) \cap (A \cup C)$

Exercises--Problem Set 1

Each of the following four statements has the truth value indicated. In problems 11-15 symbolize each sentence using A, B, C, D, $\cup$, $\cap$, and ~, and then tell if the statement is true or false.

A: The earth is round--true.
B: Deserts are dry--true.
C: Oceans are cold--false
D: The moon is flat--false.

11. The earth is round or the moon is flat.

12. Deserts are dry and oceans are cold.

13. The moon is flat and deserts are not dry.

14. It is not true that the moon is flat.

15. The earth is round, or the deserts are dry and oceans warm.

MATHEMATICAL MODEL OF OUR LOGIC

To transmit the relationships developed in the previous sections to a computer, we must build a mathematical model for our AND, OR, and NOT operations. This is a simple task since the truth value is always one of two states, either T or F. We can replace each of these with a 1 or a 0 of the binary code. Thus we arbitrarily make the following substitution:

Let T be replaced by 1,
and F be replaced by 0.

Our truth tables for AND and OR then look like this:

A	B	$A \cap B$
0	0	0
0	1	0
1	0	0
1	1	1

A	B	$A \cup B$
0	0	0
0	1	1
1	0	1
1	1	1

A computer is sometimes used to determine the truth value of a compound statement such as:

> A teacher has decided to award an A to each student who has an average of 90 or above AND who has turned in 5 or more assignments.

This statement can be represented symbolically as:

S = student who has an average of 90 or above.
A = student who has turned in 5 or more assignments.

The compound statement is then: $S \cap A$

MATHEMATICAL MODEL OF OUR LOGIC (cont.)

And the four possible combinations for each student are shown below:

CATEGORY	S	A	$S \cap A$	"A" Grade Awarded
1	F-0	0	0	No
2	F-0	1	0	No
3	T-1	0	0	No
4	T-1	1	1	Yes

It is clear that only students in category 4 received A's since students in categories 1 and 2 did not have a high enough average, while those in category 3 had not turned in enough assignments. As expected $S \cap A$ is true only when both conditions are true and otherwise it is false.

Problem Set 2

Using 0's and 1's construct the truth tables for the following:

1. $A \cup \sim A$ 2. $(A \cap B) \cap A$ 3. $(\sim A \cup B) \cap \sim C$ 4. $\sim A \cap (\sim B \cup C)$

In problems 5-7 symbolize the statement with A,B,C, etc. and determine its truth value.

A = Drawing a flowchart is difficult--This is false.
B = Logic is easy--This is true.
C = Algebra is helpful--This is true.

5. Drawing a flowchart is difficult and logic is easy. Is this statement true or false? (hint: symbolize it then draw a truth table)

6. Algebra is not helpful or logic is easy.

7. Logic is not easy and algebra useful, OR drawing a flowchart is difficult.

TRUTH TABLE DESIGN

Suppose we are given the job of finding a logical expression for C which involves A and B and which has the following truth table:

A	B	C
0	0	0
0	1	1
1	0	1
1	1	0

TRUTH TABLE DESIGN (cont.)

We first note that this is not the truth table for $A \cap B$, or for $A \cup B$ both of which we have studied in detail previously. Please examine carefully each of the following truth tables.

A	B	$\sim A$	$\sim B$	$(\sim A \cap \sim B)$
0	0	1	1	1
0	1	1	0	0
1	0	0	1	0
1	1	0	0	0

Table 1

A	B	$\sim A$	$(\sim A \cap B)$
0	0	1	0
0	1	1	1
1	0	0	0
1	1	0	0

Table 2

A	B	$\sim B$	$(A \cap \sim B)$
0	0	1	0
0	1	0	0
1	0	1	1
1	1	0	0

Table 3

A	B	$A \cap B$
0	0	0
0	1	0
1	0	0
1	1	1

Table 4

Did you observe that each one has a 1 in one and only one row of the result, and that each has its 1 in a different row from each of the others?

Returning now to our original problem, that of, find a logical expression for C, we note that its truth table has 1's in only the second and third rows. We can thus find basic AND expressions with 1's in these rows and combine them using OR expressions. Our result is then:

$$C = (\sim A \cap B) \cup (A \cap \sim B)$$

We can verify that this result does give us C with a truth table.

A	B	$\sim A$	$(\sim A \cap B)$	$\sim B$	$(A \cap \sim B)$	$(\sim A \cap B) \cup (A \cap \sim B)$
0	0	1	0	1	0	0
0	1	1	1	0	0	1
1	0	0	0	1	1	1
1	1	0	0	0	0	0

Since the last column of this table corresponds exactly with C in the original problem, we conclude that the logical expression desired is:

$$(\sim A \cap B) \cup (A \cap \sim B)$$

PROBLEM SET 3

Find a logical expression which has a truth table as shown.

PROBLEM SET 3 (cont.)

1.

A	B	C
0	0	1
0	1	1
1	0	0
1	1	1

2.

C
0
0
1
1

3.

C
1
0
1
1

4.

C
1
0
1
0

Find an expression for
C = involving A,
B, etc.

Note A, B are
the same as in
Problem 1.

5. In the stairway leading to our classroom there is a light controlled by two switches--one at the top of the stairs and one at the bottom. If both switches are off, the light will be off, but it can be turned on by flipping either switch. Similarily when the light is on, it can be turned off by throwing either switch.

Develop a truth table and the logical expression which is necessary to design a circuit like this one.

INTRODUCTION TO THE LOGIC CIRCUIT BOARD

The Logic Circuit Board is a collection of many electronic components. It is useful in the design and analysis of simple circuits. In each of the boards no batteries are required. The top panel displays four lamps, four lamps, four slide switches, and four relays. Can you identify each of these units?

Notice that four sets of double eyelets marked with a minus sign are available at the center of the panel. Electrical energy required to operate any unit on the board can be obtained by inserting the tapered pin at the end of the connecting wire into any of these eyelets, and then inserting the free end of the wire into the eyelet connected to the element which is to be operated. To prevent breakage always grasp the tapered pin by the plastic grip and insert or remove the wire with a twisting motion. Otherwise, the wire will be broken away from the pin.

Each terminal is connected to two eyelets. This is sufficient to connect any desired circuit since an arbitrary number of terminals can be connected together by a chain of jumpers.

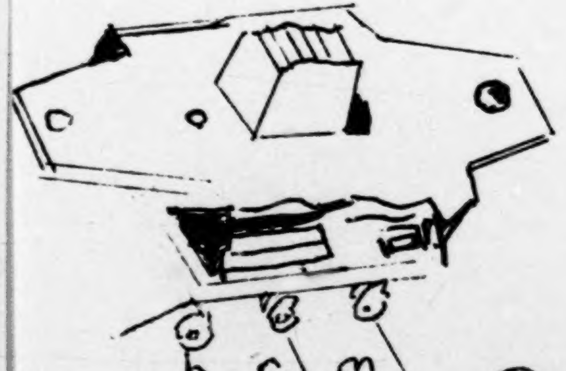


FIGURE 1

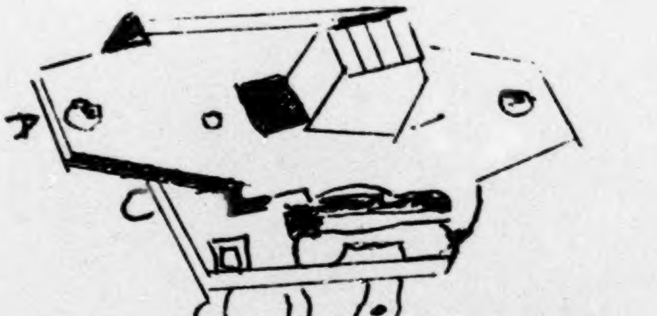
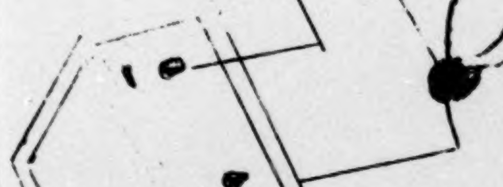


Figure 2



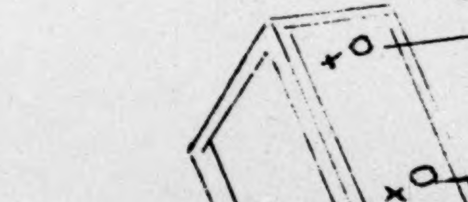


Figure 3

A	L1
0	0
1	1

Fig 4

Figure 1 shows a slide switch cut away so that you may see how it works. In Fig. 1 the switch is in the "0" position. The metal bridge carried by the insulating handle is connecting the terminal b to the terminal c. Since the lamp is wired to the battery through terminals m and c there is a gap in the metallic path between m and c and the lamp is not lit.

In Fig. 2 the switch has been operated and thus the slider is in the "1" position. Now the metal bridge connects terminals m and c, since there is a complete metallic path from the battery through the lamp it is lit.

Figure 3 is a circuit diagram arranged to show how the circuit symbols correspond to the switch, lamp battery and wires in the pictures.

For clarity the details of a slide switch are drawn for only one contact on the switch. Each of these switches each have four sets of such contacts. The 4 sets are insulated from each other but are logically connected, whenever the slider is operated all four make contacts are closed and whenever the switch is returned to a non-operated position all four of the break contacts are closed.

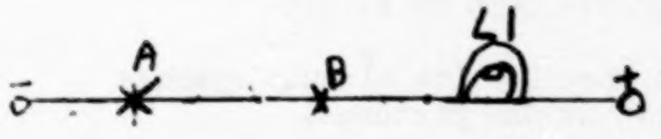
Figure 4 shows the truth table for the switch A. If A is open (not operated) then the light (A1) is off (0). However, when the switch is operated (closed) the light (L1) goes on giving a truth value of 1.

In our first learning experience with the LCB let us wire the circuit shown in Fig.1. We wish to control Lamp L1 with switch A. Let us use the section 1 contacts controlled by switch A. To do this connect a wire from Lamp L1 to the m (make) eyelet of section 1 of A. The diagram (Fig. 3) indicates that the other contact of section A1 must connect to the minus terminal for electrical energy. The c (common) eyelet represents the other contact of the switch circuit by operating switch A. Now shift the tapered pin from the minus (-) eyelets on the panel. Chehk your circuit by operating switch A. Now shift the tapered pin from the minus terminal on the panel and to any other negative terminal and observe the action of the switch.

The operation of this circuit is described by the Table of Combinations (Fig. 4) Column A represents the state of switch A and Column L1 represents the state of Lamp L1. Thus a zero (0) under the A designates "Switch A is not operated," while a one (1) in Column A designates Switch A is operated. Correspondingly a zero under L1 represents Lamp L1 is not lighted and a one (1) in Column L1 states Lamp L1 is lighted. Check the Table in Figure 4, using the circuit you wired.

PROBLEM SET 4

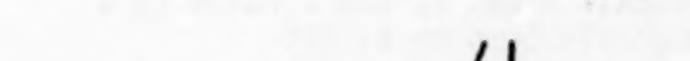
1. Connect L1 and two contacts of switches A and B as shown below.



A	B	L1
0	0	
0	1	
1	0	
1	1	

2. Operate switches A and B, observe Lamp L1, and complete the Table, above. Why is the circuit called an AND circuit? How many ones are in the output column of the Table?

3. Connect L1 and the contacts of A and B as shown in Fig. below. What is the effect on L1 ~~of~~ off operating (1) A only, (2) B only, (3) A and B? Explain.



A	B	L1
0	0	
0	1	
1	0	
1	1	

4. Complete the Table, Fig. above. Explain why this circuit is called an OR circuit. How many ones in the output column of the Table?

5. How many ones 1's would be found in the output column of a Table for A AND B AND C? Verify by wiring a circuit and constructing a table of combinations.

6. In order to initiate a call, the receiver in a telephone booth must be lifted and a coin deposited in order to obtain a dial tone. Each of these acts operates a switch. Prepare a logical expression and a circuit diagram that meets these requirements. Wire it upon the board and prepare a table of combinations.

7. The fire alarm system of a school has a number of switches, lets say four, located throughout the building. Prepare a logical expression and circuit diagram showing how any one of four switches may be used to sound the alarm. Wire it up on the logic circuit board. Prepare a table of combinations.

COMPUTER LANGUAGE

BASIC is a compiler language that was developed at Dartmouth College in eptember of 1963 by Professors John G. Kemeny and Thomas E. Kurtz. The bbreviation BASIC stands for 'Beginner's All-purpose Symbolic Instruction Code.' his language was originally designed to be a simple language that students ould use after a few hours of study. The language has since been expanded nto a more powerful, general-purpose programming language, but the simple core as been retained. The novice can use the simple statements of elementary ASIC whether or not he is aware of the additional features available to the ore expert programmer.

The best way to learn BASIC is sit down at the teletypewriter, and do some ASIC programming. The teletypewriter keyboard is similar to a typewriter's, xcept that there are no lower-case letters. There is no backspace key, but ASIC does allow the programmer to correct errors as he types. Typing a left rrow (←) effectively backspaces the teletypewriter one space. For example:

```
110 FAX←←OR I = 1 to 0
```

ould be recognized by the computer as

```
110 FOR I = 1 to 10
```

itting the key marked RETURN signifies the end of the statement and returns he teletypewriter to the left edge of the paper; the computer will send a INE FEED to the teletypewriter to advance the paper one line and indicate hat it is ready for the next statement.

Here is an example of a simple program in BASIC; it's a program for calulating the hypotenuse of a right triangle.

```
10 LET X = 5
20 LET Y = 10
30 LET HI = SQR (X↑2 + Y↑2)
40 PRINT "THE HYPOTENUSE IS," HI
50 END
```

ll statements begin with a number which serves to identify that particular tatement and shows the position of that statement in relation to the rest of he program statements. Second, the statement itself, which follows the tatement number, always begins with an English word that serves to identify hat type of statement it is.

Statements need not be entered in order as the program is composed, but he program is executed in order of ascending statement numbers. Experienced rogrammers usually choose statement numbers which are multiples of five or ten; his is to leave room for inserting additional statements later, should they e needed. Also, a statement can be deleted from a program by typing the stateent number and then hitting the RETURN key.

ariables, Expressions, and Operations

Variables are the names we use in two ways. First, to represent numbers d second at the same time, the names of computer cells where these numbers re located.

8. **Here is a circuit problem for you to solve. You are given swithces A and B and Lamp L1. Draw a circuit that will light the lamp only if A is operated AND B is NOT operated. Prepare a Table of Combinations for this problem. Wire your circuit and check it against the Table. If necessary correct your circuit. Draw the correct circuit diagram and the Table in the spaces below.**

Variables, Expressions, and Operations (cont.)

Examples of numbers we can use in the BASIC language are:

16, -3.2, 3.1416, 14E5, -0.6E4

The last two may seem strange to you, but they are quite simple. The letter "E" stands for exponent and means "10 raised to a power." Thus

14E5 is 14 X 10^5 = 1,400,000

-0.6E-4 is -0.6 X 10^{-4} = -0.00006

A variable may be named in BASIC with a single letter of the alphabet or with a letter of the alphabet followed by a single digit, 0 through 9. (i.e. Q, E1, X, Z6)

Any constant used in a program can be an integer or a decimal fraction. For example,

6, 5.7, -12.5

An expression is:
1) a variable, or
2) a constant, or
3) any combination of variables and/or constants connected by operaters.

Thus

K, 10.5, K↑2 + (3*14.6 + X), C3, $Y+X^1$

are examples of expressions in BASIC.

The arithmetic operaters in BASIC are:

* multiplication	+ addition
/ division	- subtraction

Also, since there is no way of writing X^2 on the teletypewriter, the symbol ↑ was chosen to signify exponentiation. Thus, X↑2 means X^2.

TYPES of Statements

1. The LET Statement

When a Let statement is executed the variable on the left side of the equals sign is assigned the value of the expression on the right side. The form of this statement is:

Let X = K + 1

This causes the computer to add one to the value stored in K and to store this sum in the cell named X. The general form of this statement is:

```
LET <variable> = expression
```

In some computer systems, for example the Hewlett-Packard, the LET can be omitted. THUS LET X = K + 1 could be written X = K + 1 on such systems.

2. The PRINT Statement

This statement causes the system to print output from the program on the teletypewriter. An example is:

```
PRINT  "THE SUM OF 2 + 2 IS" X
```

The general form is:

```
       expression       expression
PRINT <    or     >,  <     or      >...
        message          message
```

To print a message we simply enclose the message within quotation marks in the PRINT statement. We may print the value of any variable, constant, or formula by including it in the PRINT statement. The word PRINT followed by nothing causes the teletype to space one line upon execution.

3. The END Statement

Every BASIC program must have an END statement and it must have the largest statement number of any in the program.

4. The GO TO Statement

This statement alters the normal sequential execution of program statements and transfers control to a specified statement number. An example of this statement is:

```
10 GO TO 30
```

This statement causes the computer to take its next instruction from line number 30, and to proceed sequentially from that point. The general form of this statement is:

```
GO TO <Statement Number>
```

The program then continues from the line specified in the GO TO statement.

5. READ and DATA Statements

The general form of these statements is:

5. READ and DATA Statements (cont.):

```
READ < variable list >

DATA < number list >
```

and specific examples are:

```
10 READ X,Y,Z

20 DATA 1,2,3
```

Whenever a READ statement is used in a program there must be at least one DATA statement in the program. When the first READ statement is executed, the first number in the lowest numbered DATA statement is assigned to the first variable in the READ list, the second number to the second variable, and so on until the READ variable list is satisfied. Subsequent READ statements will begin reading data where the previous READ left off.

The INPUT Statement

This statement is used when the programmer wants to input numbers into his program from the keyboard as the program executes. The general form is:

```
INPUT <variable, variable,.....>
```

and a specific example is:

```
35 INPUT X,Y,Z
```

When the INPUT statement of the program is executed, the teletypewriter will type a question mark, indicating that input is to be typed. The programmer responds with the correct values for the variables. He then presses the RETURN key, and the program continues.

7. The IF-THEN Statement

This statement tests for equality or inequality between two expressions and transfers control depending on whether the test is true or false. An example of this statement is:

```
50 IF X = K/2 THEN 35.
```

This causes the computer to compare the value of the number in X with one-half the value of the number stored in K. If they are equal the computer will take its next instruction from line number 35. If they are not equal the instruction following line number 50 will be the next one executed. The general form of this instruction is:

```
IF < expression > relational operator < expression >
  THEN < statement number >
```

The relational operators allowed are:

```
 <  less than
 >  greater than
 <= less than or equal
 >= greater than or equal
 =  equal
 <> not equal
```

If the test is true, control will transfer to the statement number following the THEN. If the test is false, control transfers to the next sequential statement.

8. The FOR ... NEXT Statements

Often in a program it is necessary to loop through a group of statements several times to perform a calculation or a printout. The FOR ... NEXT statement does this with a minimum of programming effort. The general form of the two statements is:

```
FOR < variable > = < expression > TO < expression > STEP < expression >
    ______
    ______
    ______
    ______

NEXT < variable >
```

and a specific example is:

```
10 FOR X = 2 TO 20 STEP 5
20 LET Y = X↑2 + 3
30 PRINT Y
40 NEXT X
```

The values of the expressions for the initial and final values are computed once upon entry into loop, as is the step size. If the step size is omitted, it is assumed to be one. Let us consider the example:

```
10 FOR X = 5 to 25 STEP 4
20 PRINT X
30 NEXT X
40 ----------
```

Upon entry to the FOR loop in statement 10 of the example, the variable X is set to the value 5. Statement 20 is executed, and then the NEXT X statement at 30 directs control back to the beginning of the loop at statement 10. X is now increased by 4 and the process repeats itself. When X is larger than 25, the FOR-NEXT loop is completed and control is transfered to line 40.

9. The REM Statement

9. The REM Statement (cont.)

The REM statement is used to insert comments into programs, for explanation and future documentation. For example,

```
10 LET Z = 3
20 REM Z IS THE LENGTH OF THE RECTANGLE
30 PRINT Z
```

The computer does not print or act upon this type statement. It is for information only.

CONTROL COMMANDS

There are several commands that may be given to the computer by typing the command at the start of a new line (no line number) and following the command with a CARRIAGE RETURN.

STOP- Stops all operations at once, even when the teletypewriter is typing.

RUN- Begins the computation of a program.

SCRATCH- Destroys the problem currently being worked on; it gives the user a "clean sheet" to work on.

LIST- Causes an up-to-date listing of the program to be typed out beginning at line number XXXX and continuing to the end.

In conclusion, programs written according to the rules given, will run on any system using the BASIC language. Programs should be prepared on "local" according to the instructions on the following page and then "RUN" on the computer. Instructions for running are given on page 83.

TO PREPARE A PAPER TAPE

1. Turn the control knob on the lower right of console to "Local." This turns on the typewriter but nothing will go out over the telephone line.

2. Press "ON" button on left of console (paper tape punch.) This turns on the punch.

3. Press "RUB OUT" and "REPEAT" keys simutaneously. This gives a "leader" on the tape.

4. Type program. You may leave spaces whereever you please.

5. At the end of each line, type "RETURN" and "LINE FEED" and "RUB OUT" in this order.

6. If you make a mistake while making a tape, you may do one of three things.

   a. Retype the entire line.

   b. BACKSPACE the tape, the number of spaces required and the same number of "RUB OUTS".

   c. Type a left arrow, ←, for each letter, number or space which you want the computer to ignore.

   After doing either b or c, retype the item correctly.

7. After the last RETURN AND LINE FEED, punch about an inch or two of RUB OUTS and tear tape off.

8. Turn control to "OFF" (lower right side).

TO OPERATE THE COMPUTER

1. Place paper tape in Tape Reader. Be sure reader is in "Free" position.
2. Turn acoustic coupler "ON".
3. Turn control knob to "Line".
4. Using the telephone dial the following number: ______________
5. Place phone in acoustic coupler cradle.
6. Type a few letters and then press the RETURN key. The computer will respond with "???"
7. Log in by typing ______________________ and a RETURN.
8. For a new program type "Tape". (Return)
9. After the computer line feeds and returns, turn on tape reader.
10. When the tape is all run in, type "Key". (Return)
11. After it line feeds and returns type "Run". (Return)
12. Machine will then compute program and type answers.
13. If you want to stop machine while printing, type "stop" or "CTRL", "SHIFT" AND "P" key all at the same time.
14. If you want to run a program already in the computer library, type GET-(program name)
15. After computer line feeds and returns, type RUN.
16. When program is executed, type "Bye" and machine will disconnect itself.
17. Turn console to "OFF", hang up phone, and turn acoustic coupler "OFF".

Summary of BASIC Definitions and Statements

Constant: A number composed of digits with or without a decimal point and/or sign; or a number composed of digits and the letter E followed by a digit.

Line number: An integer number between 1 and 99999.

Simple variable: A single letter or
A letter followed by a digit.

Subscripted variable: Letter (expression) or
Letter (expression, expression)

Expression: A variable or
A constant or
Any combination of variables and/or constants connected by arithmetic operators.

Arithmetic operators:

First priority	↑	exponentiation
Second priority	*	multiplication
	/	division
Third priority	+	addition
	-	subtraction

Comparison:

<	Less than
>	Greater than
=	Equal to
<=	Less than or equal to
>=	Greater than or equal to
<>	Not equal to

Label: "Any letter, number, or symbol"
(except quotation marks " ")

```
READ  variable
READ  variable, variable, ---, variable

DATA  constant
DATA  constant, constant, ..., constant
DATA  constant, constant, "string"

INPUT  variable
INPUT  variable, variable, ..., variable

LET  variable = expression

GO TO  line number

IF expression   comparison   expression THEN   line number
```

```
FOR  simple variable = expression TO expression STEP expression
FOR  simple variable = expression TO expression
NEXT simple variable

PRINT
PRINT expression
PRINT label
       / label      \               / label      \
PRINT <    or        >    ;...;    <    or        >
       \ expression /               \ expression /

END
```

FUNCTIONS	SQR	square root
	INT	integer part
	RND	random number
	ABS	absolute value

PROBLEM 1

1. Make a paper tape of the following program:

```
10 PRINT "THIS PROGRAM WRITTEN BY your name"
20 PRINT
30 FOR I = 1 TO 4
40 PRINT "LEARNING ABOUT COMPUTERS IS FUN"
50 NEXT I
60 END
```

2. Call the computer and load your tape into the computer memory.

3. RUN the program.

4. Have the computer list the program.

5. Turn the output sheet and tape into your instructor.

PROBLEM 2

Write and run a computer program that will print your name 5 times and then stop.

This problem solution should include:

1. Flow chart
2. Program listing of correct program.
3. Output from computer run.

Your output should look like this:

```
PROBLEM 2 BY GERTRUDE PANSY

     GERTRUDE    PANSY
     GERTRUDE    PANSY
     GERTRUDE    PANSY
     GERTRUDE    PANSY
     GERTRUDE    PANSY


     DONE
```

```
5 LET C = 0
10 LET N = INT((6*(RND(1))+
20 PRINT N
25 LET C = C+1
30 IF C = 25 THEN 50
40 GO TO 10
50 END
```

PROBLEM 3

Write and run a BASIC program that will do the following:

> Assume that you can save money as follows: 1 cent the first day, 2 cents the second day, 4 cents the third day, 8 cents the fourth day,....etc. each day doubling the amount previously saved. Have the computer print out a table showing the results of following this plan for 30 days. How much would you have to save the 30th day? What is the total amount you would have saved after 30 days?

The problem solution should include:

1. A flow chart.
2. Program listing.
3. Output from a computer run of the program.
4. Answers to the questions.

Your output should look like this:

```
PROBLEM 3 WRITTEN BY GERTRUDE PANSY

DAYS          DAILY AMOUNT           TOTAL SAVED
 1               .01                    .01
 2               .02                    .03
 3               .04                    .07
 4               .08                    .15
 .                .                      .
 .                .                      .
 .                .                      .
30                ?                      ?
```

PROBLEM 4

Write and run a BASIC program that will count by 2's from a starting point which is input from the teletype keyboard during the run. The computer should stop after it has counted 5 numbers.

The probelm solution should include:

1. Flow chart.
2. Program listing.
3. Two different computer runs.

PROBLEM 4 (cont.)

Your output should look like this:

```
PROBLEM 4 BY GERTRUDE PANSY

??        16

    16        18        20        22        24

??        4

    4         6         8         10        12

?? (Type Control C)

    DONE
```

PROBLEM 5

Write a "BASIC" program that will print out N integers starting with A. Then modify the program to calculate the sum of the N integers, along with printing out the integers themselves.

This problem solution should include:

1. Two flow diagrams
2. Two computer programs
3. Two program listings
4. Output from the computer runs of the programs.

Your output should look like this:

```
PROBLEM 5 BY GERTRUDE PANSY

1    2    3    4    5

6    7    etc.

The sum of N integers is ________.
```

PROBLEM 6

Write a BASIC computer program which will input two numbers from the teletype keyboard, both of which are less than 150, and find their sum. The computer should print out the numbers, the sum, and tell whether the sum is greater than 200.

This problem solution should include:

1. **A flow chart**
2. **Program listing**
3. **Computer run which includes at least 3 pairs of numbers with sums over 200 and 2 pairs with sums less than 200.**

Your output should look like this:

```
PROBLEM 6 BY GERTRUDE PANSY

?? 3, 5

    THE SUM OF 3 AND 5 IS 8 AND
    THIS IS LESS THAN 200.

?? 147, 102

    THE SUM OF 147 AND 102 IS 249 AND
    THIS IS GREATER THAN 200.
```

PROBLEM 7

Write a "BASIC" program that will convert inches and feet to meters and centimeters. Use a READ-DATA statement.

Your problem solution should include:

1. **Flow diagram**
2. **Program listing**
3. **Output from a good computer run**

Your output should look like this:

```
PROBLEM 7 BY GERTRUDE PANSY

39.37 in. = 1 meter
 3 ft. 8 in. = ? meter ? centimeters
```

PROBLEM 8

Write a computer program to solve the following problem:

> Mr. I.M. Shrewd wants to know the difference in interest if his savings account (present balance is $250) is compounded annually, semi-annually, quarterly, daily, or hourly. Assume the current rate of interest is 6 percent and that Shrewd plans to leave the money in the account for 10 years.

This problem solution should include:

1. Flow chart
2. Program listing
3. Output from the computer run.

Your output should look like this:

```
              PROBLEM 8 BY GERTRUDE PANSY

                            INTEREST EARNED

YEAR    PRINCIPAL      ANNUAL      SEMI-ANN.     QUARTERLY     DAILY     HRLY.
  1      250.00
  2
  3
  .
  .
  .
 10
```

PROBLEM 9

Write a "BASIC" program that will compute the sum of the first 1000 positive integers. Use a FOR-NEXT loop.

Your problem solution should include:

1. Flow diagram
2. Program listing
3. Output from a good computer run

Your output should look like this:

```
PROBLEM 9 BY GERTRUDE PANSY

THE SUM OF THE FIRST 1000 INTEGERS IS ______________.
```

PROBLEM 10

Regularly each month, Mrs. Ima Saver deposits $600 into a joint savings account, an unknown to Ima but just as regularly each month, her husband, Worthmore withdraws half of the then current balance. After a year of these goings-on, how much money does Mrs. Saver think they have in the account and what is the actual balance? You can neglect interest and round off errors.

Your solution to this problem should include:

1. A flow chart
2. Program listing
3. Output from the computer run

Your output should look like this:

```
            PROBLEM 10 WRITTEN BY GERTRUDE PANSY

MONTHS          EXPECTED          ACTUAL          TOTAL AMT.
                BALANCE           BALANCE         WORTHMORE TOOK

  1              600.00           300.00             300.00
  2             1200.00           450.00             750.00
  3
  4
  .
  .
  .
 12
```

PROBLEM 11

Write a "BASIC" program to give the slope of a line given any two points. Use a DATA statement.

Your problem solution should include:

1. A flow chart
2. Program listing
3. Output from a good computer run

Your output should look like this:

```
PROBLEM 11 BY GERTRUDE PANSY

THE SLOPE OF THE LINE WITH POINTS
  (2,3) AND (5,7) IS ________.
.
.
OUT OF DATA LINE 10
```

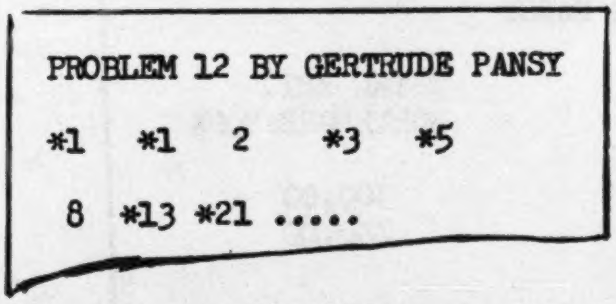
PROBLEM 12

Write a "BASIC" program to determine and print out in horizontal lines the first 20 terms in the Fibonacci sequence. Your program should also indicate those terms which are odd numbers. (You may use any method you wish to design in order to do so.)
The Fibonacci sequence is the sequence of numbers 1, 1, 2, 3, 5, 8, 13, 21, ..., each of which is the sum of the two previous numbers (these numbers are called Fibonacci numbers).

Your problem solution should include:

1. Flow diagram
2. Program listing
3. Output from a good computer run

Your output should look something like this:



```
PROBLEM 12 BY GERTRUDE PANSY

*1   *1   2    *3   *5

 8  *13 *21 .....
```

PROBLEM 13   Carbon-14 Dating

The decay curve for radioactive elements is exponential and of the form

$$A = a \cdot b^{kt},$$

where a is the initial amount of the element present, and A the quantity present after t units of time. The base b and the constant K will depend upon the element and the choice of units for time. The half-life of radioactive decay is the time in which the amount of a given radioactive material decreases to one-half its original amount. Radioactive Carbon 14 is created by the action of cosmic rays on the atmosphere, and the amount present in a living substance remains approximately constant. Growing plants and the animals that eat the plants absorb carbon-14 during their life, but the process stops when the plant or animal dies. Radioactive decay then causes the relative amount of carbon-14 to decrease. Measurement of this loss of radioactivity in fossils permits an estimate to be made of their age. Such a process is known as carbon-14 dating.

Consider the following law of decay for a specific fossil and the elemt Carbon-14,

$$A = 400 \cdot 2^{kt}$$

where A is the amount of C-14 present in milligrams after t years. You are to prepare a "BASIC" program that will compute the amount of C-14 present after 500, 1000, 1500, 2000, 2500, ... thru 10,000 years. From this data sketch a curve showing the amount of C-14 present in an object as a function of time. From this curve determine the following:

a) amount of C-14 after 8,250 years
b) number of years required to reduce the C-14 content to 225 milligrams.

PROBLEM 13 (cont.)

The output from the computer should look like this:

```
PROBLEM 13 BY GERTRUDE PANSY

 ---------------        T (in years) A (in milligrams)
|               |            ?              ?
|               |
|               |
 ---------------
```

Your graph goes here

PROBLEM 14

Assume the population of our country is 200 million. Also assume each person requires at least 4 square feet of space. How many square miles are required to hold the population? Do we have this much land in our country? Let us make the problem more general by allowing the population to increase in increments of 25 million thru 500 and assume that each person requires 4 sq. ft., 1 sq. yd., ½ acre, 1 acre

Let us use the formula

$$\text{sq. miles} = \frac{P \cdot Y}{3.0976} \qquad \text{where}$$

P = Millions of people
Y = Square yard per person

This problem solution should include

1. A flow chart
2. Program listing
3. Output from a computer run.

Your output should look like this:

```
          PROBLEM 14 WRITTEN BY GERTRUDE PANSY

NO. OF PEOPLE          SQUARE MILES REQUIRED IF SPACE PER PERSON IS . . .
(IN MILLIONS)           4 sq. ft.         1 sq. yd.        ½ acre      1 acre
   200                    ____              ____            ____        ____
   225                    ____              ____            ____        ____
    .                      .                 .               .           .
    .                      .                 .               .           .
    .                      .                 .               .           .
   500                    ____              ____            ____        ____
```

PROBLEM 15

Write a "BASIC" program that calculates the area of any triangle given the lengths of the three sides. Use Hero's Formula: Area of $\triangle ABC = \sqrt{s(s-a)(s-b)(s-c)}$ (sides are a, b, and c; semiperimeter s ~~where~~ 'S

$s = \frac{1}{2}(a + b + c)$)

Your problem solution should include:

1) Flow diagram
2) Program listing
3) Output from the computer run

Your output should look like this:

```
     PROBLEM 15 BY GERTRUDE PANSY

THE AREA OF THE TRIANGLE WITH SIDES ____, _____, AND ____ is?
.
.
.
.
.
.
.
.
.
OUT OF DATA LINE 10
```

PROBLEM 16

Using the computer as a coin tossing simulator write a program to print the number of "heads" and "tails" in 5, 10, 50, 100, 200, 300, 400, 500,... 1000 tosses of a coin.

This problem solution should include:

1) A flow chart
2) Program listing
3) Output from the computer run

Your output should look like this:

```
     PROBLEM 16 WRITTEN BY GERTRUDE PANSY

NUMBER OF          NUMBER OF          NUMBER OF
TOSSES             HEADS              TAILS
  5                  __                  __
 10                  __                  __
 50                  .                   .
100                  .                   .
200                  .                   .
 .                   .                   .
 .                   __                  __
1000
```

PROBLEM 17

Write a computer program that will permit you to enter guesses for five consecutive throws of a single die. These will all be entered at the same time using an INPUT statement. Have the computer simulate the throwing of the die. If none of your guesses matches the corresponding throw you pay $5.00. With one match you win $1.00, two matches you get $3.00, three matches $10, and if all 5 guesses are correct you win $1,000! You pay nothing to enter the game. Have the computer print out the results of each throw and the winnings. Play the game 10 times and have the computer summarize your results after 10 games.

Your problem solution should include:

1. A flow chart
2. Program listing
3. Output from a good computer run

The output should look like this:

```
PROBLEM 17 WRITTEN BY GERTRUDE PANSY

MY GUESSES FOR THE FIVE THROWS ARE:
     ?? 5, 2, 1, 4, 3

THE COMPUTER THROWS THE DICE AND THE RESULTS ARE:
     2, 1, 4, 4, 3

THERE ARE TWO MATCHES, YOU WIN $3.00

YOUR TOTAL EARNINGS ARE NOW $3.00


MY GUESSES FOR THE FIVE THROWS ARE:
          .                 .
          .                 .
          .                 .
```

PROBLEM 18

A table T(1) has fifteen entries. Write a "BASIC" program that will set

T(1) = 1
T(2) = 3
T(3) = 5
T(4) = 7
.   .
. = .
.   .
etc. etc.

PROBLEM 18 (cont.)

Print the table using a FOR-NEXT loop so the output looks like this

```
T(1) = 1
T(2) = 3
T(3) = 5
```

Your problem solution should include:

1. Flow diagram
2. Program listing
3. Output from a good computer run

PROBLEM 19

Write a "BASIC" program that will sort and count a list N(I) of 30 numbers into the following lists E(I) and O(I) where

E(I) = Even Integers
O(I) = Odd Integers

The numbers will be read in by READ-DATA statements.

Your problem solution should include:

1. Flow diagram
2. Program listing
3. Output from a good computer run

Your output should look like this:

```
PROBLEM 19 BY GERTRUDE PANSY

THERE ARE 13 EVEN NUMBERS. THEY ARE:
   138, 12, 16, 24

THERE ARE 17 ODD NUMBERS.  THEY ARE:
   7, 123, 15...

OUT OF DATA LINE 10
```

PROBLEM 20

Write a "BASIC" program that will use only no more than three print statements to produce the following table;

```
9111
0911
0091
0009
```

PROBLEM 20 (cont.)

Your problem solution should include:

1. Flow diagram
2. Program listing
3. Output from a good computer run

Your output should look like this:

```
PROBLEM 20 BY GERTRUDE PANSY

9    1    1    1
0    9    1    1
0    0    9    1
0    0    0    9
```

PROBLEM 21

A Nike rocket with a 100 pound payload is fired at a launch angle of 70°. The equation describing its trajectory is $h = -0.01345T^2 + 5.222T$, where h is the altitude in thousands of feet and t is the flight time measured in seconds. Using the computer calculate the highest altitude reached by the rocket, the number of seconds required to reach max altitude, and the time the rocket will be 27 miles above the earth on its return trip. Using the TAB function have the computer plot the trajectory of the rocket.

Your solution should include:

1. A flow chart
2. Program listing
3. Output from a correct computer run

The output should look like this:

```
PROBLEM 21 WRITTEN BY GERTRUDE PANSY

TIME IN SEC         ALTITUDE IN K-FEET            PLOT OF TRAJECTORY

     0                        0                 x
    10                     53.56                     x
    20                     99.06                          x
   300                        .
   320                        .                                      x
   340                        .                                  x
   360                        .                              x
   380                     42.18                          x

THE MAXIMUM ALTITUDE REACHED IS ____________ FEET
THE TIME REQUIRED TO REACH MAX. ALT IS ____________ SEC.
```

PROBLEM 21 (cont.)

```
THE FLIGHT TIME TO REACH THE 27 MILE BOUNDARY IS ____________ SEC.
```

PROBLEM 22

I. M. Sly was offered a job at $1.00 a day for the first day with the salary doubling each succeeding day. That is the salary the 2nd day would be $2.00, the 3rd day $4.00, the 4th day $8.00, etc. At the same time, R. U. Shrewd took a job at a salary of $500 a day with a $100 a day raise each day after the first. Both planned to work during their 3 months (60 summer vacation work days). Who had earned the most at the end of the 60 day period? On what day will they have earned exactly the same amount? How much will each have earned at the end of each week during the 3 month period?

Your solution should include:

1. **A flow chart**
2. **A program listing**
3. **Computer output**

The output from this problem should look like:

```
PROBLEM 22 BY GERTRUDE PANSY

WEEK NO.                 SLY'S EARNINGS              SHREWD'S EARNINGS
    1                     -    -    -                 -    -    -
    2                     -    -    -                 -    -    -
    3                     -    -    -                 -    -    -
    .                          .                           .
    .                          .                           .
    .                          .                           .
   12                     -    -    -                 -    -    -

SLY (OR SHREWD) EARNED THE MOST DURING THE SUMMER

ON DAY _______ THEY WILL BOTH HAVE EARNED THE SAME AMOUNT
```

PROBLEM 23

I. **Solve the following system of equations by hand.**

$$2x + 4y = -14$$
$$5x + y = 10$$

II. **Write a flow chart and "BASIC" program to solve the problem.**

III. **Use the program to solve the following system:**

$$2x + 3y = 5$$
$$7x - 2y = 5$$

PROBLEM 23 (cont.)

IV. **Write a program to solve any system of the type worked above. That is, using the computer solve for x and y if:**

$$\begin{aligned} Ax + By &= C \\ \text{and}\quad Dx + Ey &= F \end{aligned}$$

where A, B, C, D, E, and F are read into the computer with READ-DATA statements.

This problem solution should include:

1. **hand-solved equations**
2. **flow chart and computer program for first program**
3. **computer run for first program**
4. **flow chart and computer program for second program**
5. **computer run for second program**

```
PROBLEM 23

THE SOLUTION FOR 2x + 4y = -14 AND
5x + y = -10 IS ___(?)___

OUT OF DATA LINE 10
```

PROBLEM 24

Assume the bill for purchases is less than $100. You are to write a program that will calculate the exact change required in the smallest number of coins and bills. If the bill is more than the amount paid, print the statement, "YOU STILL OWE ________, SIR." If the payment is exact print, "THAT IS THE CORRECT AMOUNT, THANK YOU, SIR."

Your solution should include:

1. **A flow chart**
2. **Program listing**
3. **Output from the computer run with the following data**

Bill	Amount Paid
$33.33	$100.00
$5.25	$5.25
$1.06	$1.00
$7.02	$20.00

PROBLEM 24 (cont.)

Your output should look like:

```
PROBLEM 24 WRITTEN BY GERTRUDE PANSY

YOUR BILL IS $33.33                              AMOUNT PAID IS $100.00

     YOUR CHANGE IS $66.67 SIR.

          1 PENNY                               1 ONE DOLLAR BILL
          1 NICKEL                              1 FIVE DOLLAR BILL
          1 DIME                                3 TWENTY DOLLAR BILLS
          1 HALF DOLLAR


YOUR BILL IS $5.25                               AMOUNT PAID IS $5.25

     THAT IS THE CORRECT AMOUNT, THANK YOU SIR


YOUR BILL IS $1.06
          .
          .
          .
          .
```

WORKSHEET 1

Construct a truth table for $A \cap \sim(B \cup C)$

1. $A \cap \sim(B \cup C)$

2. $A \cap (B \cap C)$

Using truth tables determine if the following statements are true.

3. $A \cap \surd(\surd B) = A \cup B$

4. $A \cup (B \cap C) = (A \cup B) \cap (A \cup C)$

WORKSHEET 2

Using 0's and 1's construct truth tables for the following expressions

1. $A \cap (\sim B)$

2. $\sim A \cap (B \cup C)$

Using truth tables (0 - 1's) determine if the following expressions are true

3. $(A \cap B) \cap (\sim A \cup B) = A \cap B$

4. $(A \cap \sim B) \cup (A \cup B) = A \cup \sim A$

WORKSHEET 3

Find a logical expression that involves A and B which has the truth table indicated:

1.

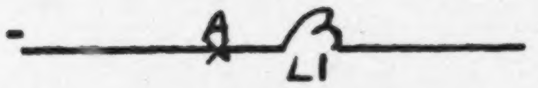
C
1
1
1
0

2.

C
0
0
1
1

WORKSHEET 4

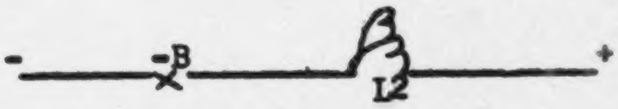
1. Wire up this circuit



and complete the table.

A	L1
0	
1	

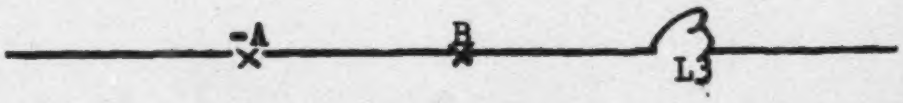
2. Wire up this circuit



and complete the table.

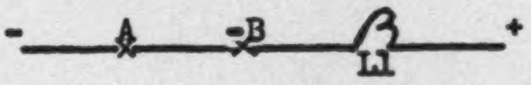
B	L2
0	
1	

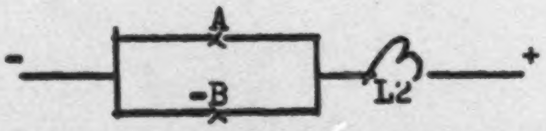
3. Wire up this circuit

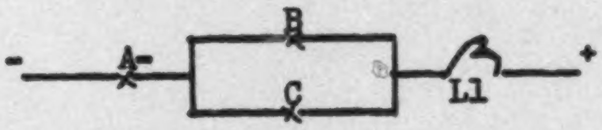


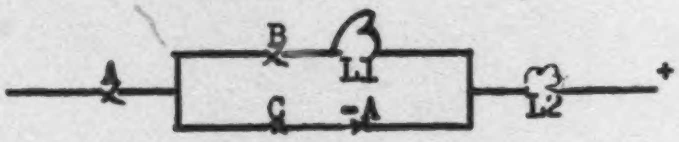
Fill out a table for all possibilities.

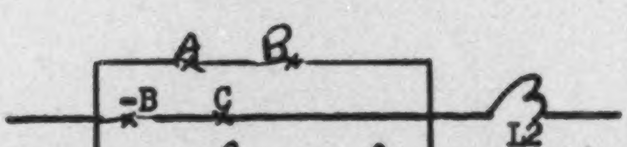
4. Same as above for those circuits.

a. 

b. 

c. 

d. 

e. 

WORKSHEET 5

Using the Logic Circuit Board Model each of the following expressions. To do this first complete a simplified diagram and connect it on the board. Using the model verify the results you obtained by completing a table of combinations. Compare these with the truth tables you developed earlier.

Logic Notes. 1. Problem Set 1: Problems 5, 8.
2. The 4 tables on page 69.
3. Problem set 3: Problems 2, 4, 5

PRACTICE QUIZ 1

Write a truth table for each of the following expressions.

1. $(A \cap B) \cup \sim A$ 2. $\sim(A \cup B)$ 3. $(A \cup \sim B) \cap \sim C$

Using a truth table tell if the following expression is a true statement.

4. $A \cup (\sim B \cap C) = (A \cup \sim B)\ C$

Show work on back

5. Design the logical expression for C which has the truth table shown.

A	B	C
		1
		1
		0
		0

WORKSHEET 6

Today you are asked to design a computer circuit that will add two numbers. To solve this problem, consider that the numbers are one digit binary numbers thatis either a 0 or a 1. We want to design a circuit that will perform all possible additions of these numbers.

$X_1 + X_2 = R$
$0 + 0 = 0$
$0 + 1 = 1$
$1 + 0 = 1$
$1 + 1 = 10$

To do this, let switch A represent one number
switch B represent other number
L_3 and L_4 represent the result.

1. Develop the truth table and the logical expression necessary to do this job.
2. Draw the electrical circuit
3. Wire on Logic circuit board
4. Check all possible addition combinations
5. Have instructer check your circuit.

Try to do the same for 3 binary numbers.

COMPUTER CAPABILITIES
MACHINE LANGUAGE

00 XY Input (INP)	This instruction causes the computer to read in data and store it in cell XY.
01 XY Clear and Add (CLA)	This instruction causes the computer to erase the present contents of the accumulator It does not change the contents of cell XY.
02 XY Add (ADD)	This instruction causes the computer to add the contents of cell XY to the accumulator. The sum is left in the accumulator and the contents of cell XY are left unchanged.
03 XY Test Accumulator (TAC)	This instruction causes the computer to examine the contents of the accumulator and if they are zero or positive to go on to next instruction. If the contents are negative, the computer takes its next instruction from cell XY.
04 XY Shift (SHF)	This instruction causes the computer to shift the contents of the accumulator left X places, then right Y places.
06 XY (STO)	This instruction causes the computer to store the contents of the accumulator in cell XY, thus replacing its previous contents. The contents of the accumulator are unchanged.
07 XY Subtract (SUB)	This instruction causes the computer to subtract the contents of cell XY from the contents of the accumulator. The difference (result) is left in the accumulator. The contents of cell XY are left unchanged.
08 XY Jump (JMP)	This instruction causes the computer to take as its next instruction the contents of cell XY.
09 00 Halt (HLT)	This instruction causes the computer to stop the sequence of instruction and terminate the job. This instruction is used to end all programs.
10 XY Zero Jump (ZJP)	This instruction examines the contents of the accumulator and if they are zero, it takes as its next instruction the contents of cell XY. Otherwise it follows the original path.
11 XY Multiply (MPY)	This instruction causes the computer to multiply the contents of cell XY with the accumulator contents. The product is left in the accumulator and the contents of cell XY are left unchanged.
12 XY Divide (DIV)	This instruction causes the computer to divide the contents of cell XY by the contents of the accumulator. The quotient is left in the accumulator and the contents of cell XY are left unchanged.
13 XY Square Root (SQR)	This instruction causes the computer to take the square root of the contents of cell SY. The result is left in the accumulator.

WORKSHEET 7

1. **Draw a flow diagram and write a computer program in machine language that will store two numbers and then print out the sum and product of the two numbers.**

2. **Draw a flow diagram and write a computer program in machine language that will compute the value of Y if $Y = 2X^2 + 3$ and $x = 4$**

3. **Draw a flow chart and write a machine language program that will count from -2 to +6 by two's.**

4. **What will the computer output for this program be:**

Call No.	**Contents**
18	0029
19	0030
20	0129
21	230
22	618
23	518
24	321
25	900
Call No.	**Contents**

If the input data is:
-4
+1

WORKSHEET 8

1. **Draw a flowchart and write a machine language computer program that will convert degrees centigrade to Fahrenheit. The formula is**

$$F = \frac{9}{5}C + 32$$

2. **Draw a flowchart and write a computer program in machine language that will find the area and perimeter of any rectangle ifyou know the length and width.**

3. **Draw a flowchart and write a program that will find the length of the hypotenuse of a right triangle if you know the lengths of the other two sides.**

4. **What will the computer output for this program be.**

Cell No.	**Instr.**
1	0099
2	0098
3	0199
4	0298
5	0312
6	1298
7	0696
8	0596
9	0815
10	1198
11	0303
12	0697
13	0597
14	0806
15	0900

5. **Draw a diagram of the major components of a computer and tell what each part does. (See page 8 in your - More About Computers book.)**

WORKSHEET 9

1. **Draw a flowchart and write a computer program that will read in a number calculate the square and the square root of the number. Print out the number, its square and its square root.**

2. **What will the computer print out from the following program.**

Cell No.	**Instr.**
1	0099
2	0098
3	0198
4	1299
5	1001
6	0697
7	0599
8	0597
9	0900
10	

Input
4
12
2

WORKSHEET 10
BASIC Programming

1. Draw a flow chart and write a program that will:

   a. Print your name and W.S. 3
   b. Read in 3 numbers and find their average
   c. Print out all three numbers and the average
   d. Repeat steps b thru d until out of data
   e. Trace your program, showing the printed output using this data statement
   DATA 1,2,3, -10, 14, 2

Flow chart

Program

Tracing

Output

2. What will the computer print out for this program?

```
10 READ A, B
20 LET D = A 2 + B
30 IF D  B THEN 60
40 PRINT D,
50 Go to
60 PRINT B
70 Go to
80 DATA 1, -2, 2, 15
90 END
```

OUTPUT--Show EXACTLY as computer would print it out.

UNDERSTANDING COMPUTER CONCEPTS

Objectives: After completing this unit of instruction each student should:

I. Be able to operate a remote terminal.

II. Be able to write computer programs in the BASIC language which utilize the following instructions:

LET
READ
DATA
GO TO
IF...THEN
INPUT
FOR...NEXT
PRINT
REM
END

and these functions
SQR
INT
RND
TAB

and incorporate these operations or procedures
addition
subtraction
multiplication
division
exponentiation
looping
edit commands
comparisons

III. Be able to flow chart, trace, debug, and document a computer program.

IV. Have an understanding of what a computer is, how it developed, how it works, what it can and cannot do, and how it affects his life and society.

Activities: During this unit each student will:

I. Read and study student notes on "Understanding Computer Concepts, and "More About Computers".

II. Write and run at least 7 computer programs.

III. Read and abstract articles from current computer journals.

IV. Make significant contributions to the small group discussions.

V. Visit a computer installation and discuss its operation with people in the computer industry.

EVALUATION: Students will be evaluated in this unit on the following:

I. The number and quality of computer programs turned on.

II. Their contribution to the small group discussions.

III. The quality of their article abstracts.

IV. Operation of a teletype terminal.

V. Their ability to flowchart, program, debug, and document a computer program.

LESSON I - INTRODUCTION TO COMPUTERS

Objective: After completing this lesson the student should:

I. Understand and be able to discuss a computer's

  a. Historical growth and development

  b. General System Organization

II. Be able to operate a teletype terminal.

Activities:

I. Discuss pages 1-16 "More About Computers".

II. Have students complete Figure #1.

III. Show a tube, resistor, chip, magnetic tape, and memory unit.

IV. Using projectual #1 discuss the organization of a computer.

V. Demonstrate the correct procedure for terminal operation.

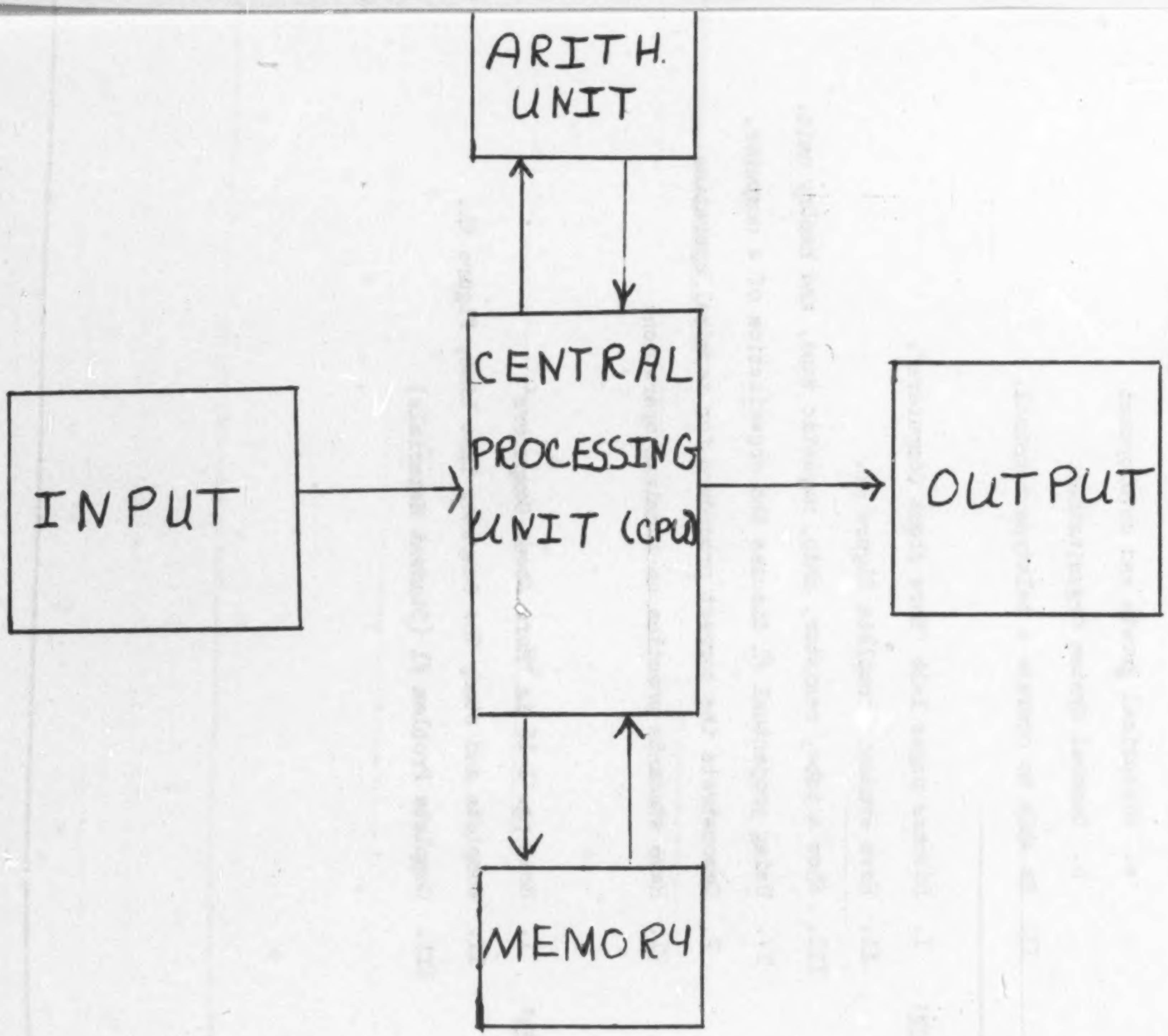
VI. Have students practice on terminal operation.

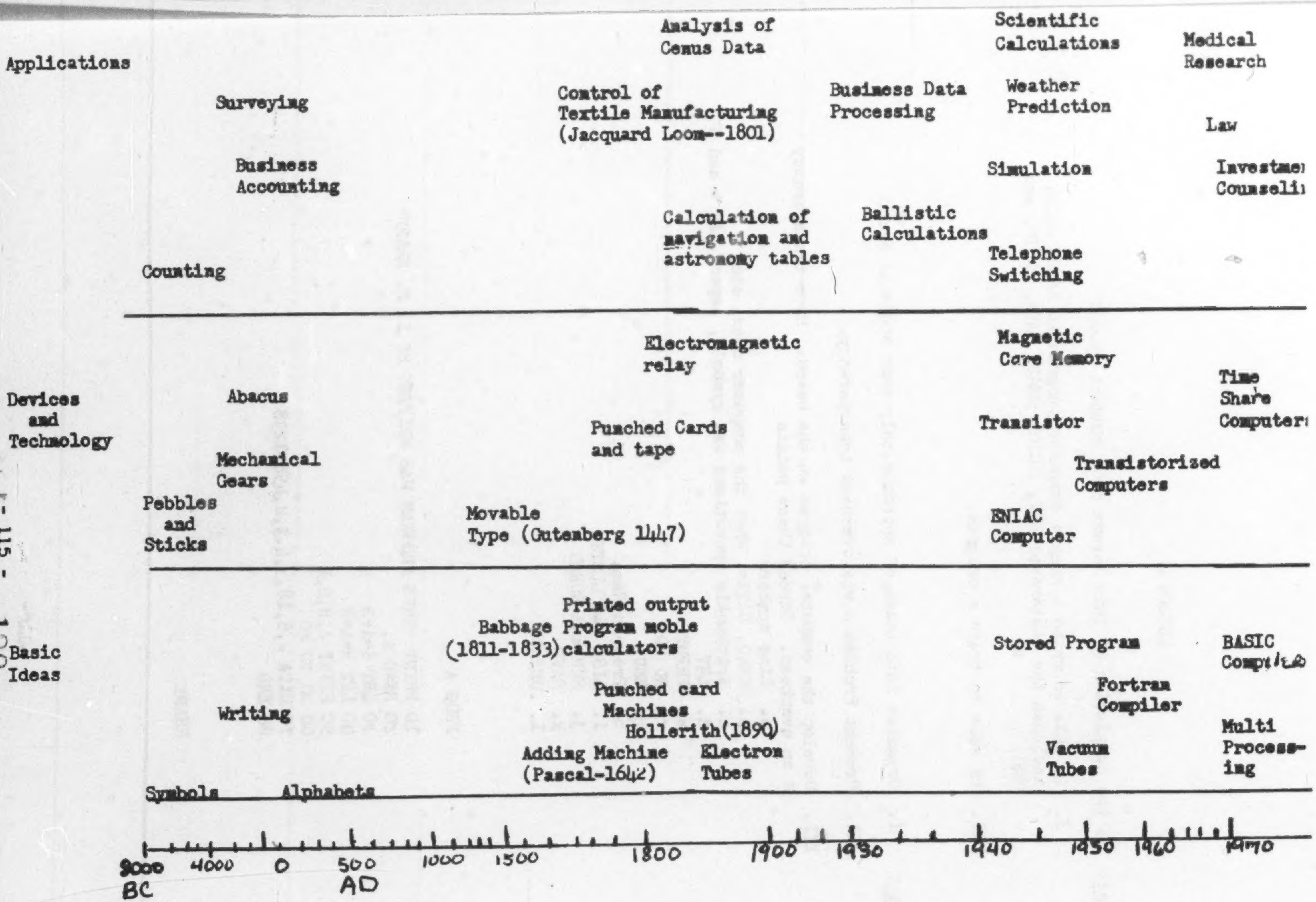
Home Assignment:

I. Read pg. 1-16 in "More About Computers"

II. Complete and study The Computer Time Line, Figure #1.

III. Complete Problem #1 (Student Materials).


ARITH. UNIT
INPUT
CENTRAL PROCESSING UNIT (CPU)
OUTPUT
MEMORY


Applications
Surveying
Business Accounting
Counting
Control of Textile Manufacturing (Jacquard Loom--1801)
Analysis of Cenus Data
Calculation of navigation and astronomy tables
Business Data Processing
Ballistic Calculations
Scientific Calculations
Weather Prediction
Simulation
Telephone Switching
Medical Research
Law
Investme
Counseli
Devices and Technology
Abacus
Mechanical Gears
Pebbles and Sticks
Movable Type (Gutenberg 1447)
Electromagnetic relay
Punched Cards and tape
Magnetic Core Memory
Transistor
ENIAC Computer
Transistorized Computers
Time Share Computer
Basic Ideas
Writing
Symbols
Alphabets
Babbage (1811-1833)
Printed output
Program moble calculators
Adding Machine (Pascal-1642)
Punched card Machines
Hollerith(1890)
Electron Tubes
Stored Program
Fortran Compiler
Vacuum Tubes
BASIC Compile
Multi Processing
9000 BC
4000
0
500 AD
1000
1500
1800
1900
1930
1940
1950
1960
1970

COMPUTER TIME LINE

LESSON 2

Objectives: At the completion of this lesson each student should

I. Be able to write a simple computer program in BASIC which includes the statements LET, PRINT, READ, DATA, GO TO, and END.

II. Be able to trace a program.

Activities: I. Organize into teams of approximately four students each.

II. Present Problem A via overhead transparency.

III. Develop the computer program at the board. Have transparency 2 on overhead. Stress these points

- a. Line numbers
- b. READ, DATA: What the computer does, etc.
- c. Arithmetic operations and symbols, especially * and ↑
- d. LET
- e. PRINT
- f. GO TO
- g. END
- h. Program Name
- i. LIST and LISTNH
- j. RUN and RUNNH
- k. SAVE
- l. UNSAVE

```
PROG A

10 PRINT "THIS PROGRAM WAS WRITTEN BY I. M. SHARP"
20 READ A,
30 LET S=A+B
40 LET P=A*B
50 PRINT A,B,S,P
60 GO TO 20
70 DATA 2,6,18,3,4.3,2,456,1238
80 END


READY
```

COMPUTER MEMORY

A	B	S	P
~~2~~ ~~18~~ ~~4.3~~ 456	~~6~~ ~~3~~ ~~2~~ 1238	~~8~~ ~~21~~ ~~6.3~~ 1694	~~12~~ ~~54~~ ~~8.6~~ 564528

COMPUTER OUTPUT

```
THIS PROGRAM WAS WRITTEN BY I.M. SHARP

   2                6                  8            12
  18                3                 21            54
  4.3               2                 6.3           8.6
  456             1238               1694         564528
```

A. **Have student make tape and run the program.**

Home
<u>Assignment</u>: **Have students program**

I. Problem #2

II. Problem #3

PROBLEM NO. A

Write a computer program in BASIC which will

1. Print the following statement:
   PROGRAM WRITTEN BY (Your name)

2. READ 2 numbers from a data list.

3. Form the sum and product of these two numbers.

4. Print the two numbers, their sum and their product.

5. Read two more numbers and repeat the process.

SUMMARY OF BASIC COMMANDS

WORD	PURPOSE	EXAMPLE
READ	**Reads data from a data statement in program**	40 READ X, Y1, M(2)
PRINT	**Types output statements and numerical answers**	50 PRINT "AREA IS"; A
LET	**Computes and assigns values**	60 LET X1 = X + Y3
GO TO	**Transfers control**	80 GO TO 165
IF···THEN	**Conditional transfer**	30 IF X = 0 THEN 150
DATA	**Stores data to be used in problem**	90 DATA 3, 5.1, 3.14192, 127829
VARIABLES	**The variables may be symbolized with a letter, or a letter and a number**	X, Y7, A, B(3), D(A)
OPERATIONS	**These are the arithmetic operations**	↑ *, /, +, -, **exp. mult. div. add. subt.** **1st 2nd 3rd** **order of execution**

LESSON 3

Objectives: At the completion of this lesson each student should:

I. Be able to write a simple computer program in BASIC which includes all statements from lesson 2 plus IF...THEN... and INPUT statements.

II. Be able to trace a program.

Activities: I. Discuss what IF...THEN... and INPUT statements do.

II. Present problem number B on overhead.

III. Develop program at board. Have transparency #3 on overhead.

IV. Present problem number 4 on dittoed sheets.

V. Have groups write and run program number B in class.

VI. Have students work on home assignment.

Home Assignment: I. Complete Problem #16.

LESSON 4

Objectives: I. To review the concept in lessons 1, 2, and 3.

II. To demonstrate how a computer can be used as an instructional tool.

Activities: I. Have students working in groups of two complete Review Test I

II. Complete all assigned work in lessons 1, 2, 3.

III. Extra credit points can be earned by completing Problem 13.

PROBLEM NO. B

An engineer needs to calculate the area of several rectangles. He knows only the length and width of each. Since he will be making these calculations many times in the future, he would like to computerize the job. Write a BASIC program that will help him do it. Assume data will be input from The Keyboard, and that rectangles with area greater than 500 ft.^{2} should specially be noted.

LESSON 5

Objectives: At the completion of this lesson each student should:

I. Be able to write a simple computer program which includes all statements from lesson 3 plus the FOR... NEXT statement.

II. Be able to trace the program.

Activities:

I. Discuss looping procedures.

II. Discuss the FOR... NEXT statement.

III. Present problem #C.

IV. Develop solution to problem #C.

V. Have students work problem #1C.

VI. Have students work on Home Assignment.

PROBLEM NO. C

Find the maximum area that can be enclosed with 250 feet of fencing, if the shape of the area is rectangular.

PROBLEM NO. 1C

Write a computer program that will:

1. Print the statement
THIS PROGRAM WAS WRITTEN BY (Your Name)
2. Compute the amount of time required to pay off a loan of $2500.00 at 5% if the monthly payment is $50.00
3. Compute the total amount of interest paid on a loan of $35,000 at 9% if it is paid off in 30 years.

Home Assignment:

I. Complete problem #8.

LESSON 6

Objectives: At the completion of this lesson each student should:

I. Be able to write a simple computer program which includes all statements from lesson 5 plus the functions SQR, INT, RND, and TAB.

II. Be able to trace the program.

Activities:

I. Discuss the special functions SQR, INT, RND, and TAB. Tell what each one does.

II. Present problem D on overhead.

III. Develop solution to problem D.

IV. Have students solve problem 1D

V. Have students work on Home Assignment.

PROBLEM NO. D

Have the computer generate and print out 10 random numbers from 3 to [illegible]

PROBLEM NO. 1D

Write a computer program that will:

1. Print the statement, "THIS PROGRAM WAS WRITTEN BY (**Team Members Names**).
2. Generate and print out 25 random numbers either 0 or 1. (Simulate 25 tosses of a coin.)
3. Generate and print out 10 random numbers from 1 to 6. (Simulate 10 throws of a dice.)
4. Generate and print out 15 random numbers from 2 to 12. (Simulate 15 throws of 2 dice.)

Home Assignment: I. Complete Problem #16.

LESSON 7

Objectives: I. To allow students to work on their computer assignments and to ask any questions they have.

Home Assignment: I. Complete Problem #17.

II. Extra credit will be given for #10.

At this point the following problems should be completed and turned in:

Problems #1, 2, 3, 6, 8, 16, 17

Extra Credit for #10, 13

LESSON 8

Objectives: After completing this lesson students should be able to:

I. List professions, businesses, and skills now utilizing the computer.

II. Indicate new and possible uses or areas of use for the computer in the next 30 years.

III. Discuss the impact of computer technology on:
   a. Industrial automation: the creation and/or elimination of jobs; the changing character of the work force.
   b. Social change: banking and credit system, personal data banks, leisure time.
   c. Economics and Politics: stock market simulation, predicting the future of our economy, vote counting and prediction of a candidates victory.
   d. Professions: medicine, law, engineering, education
   e. Life Style in Suburban America: how has the computer changed your life or that of your parents?

IV. Compare various computer characteristics such as size, cost, purposes, and time or speed of operation.

V. Describe a typical computer installation.

Activities: I. Students will read and abstract 5 articles from current periodicals of the computer industry.

II. Students will view "The Computer Revolution Parts I and II."

III. Students will prepare a 350-500 word paper on "The Effect of the Computer On ______________"

IV. Students will present their papers to their small group and will contribute significantly to a group discussion on "The Effect of Computers on Our Society."

V. Students will visit a computer facility to observe first hand the size, type of installation, and physical layout of a computer; and to discuss various aspects of computer technology with the technicians employed in a computer center.

VI. Students will keep a notebook with current newspaper and magazine articles discussing computers and computer related activities.

THE COMPUTER REVOLUTION, PART I

Length and Type: 30 min., color, sound.

Source:

Summary: This film is one of the CBS "21st Century" series. It shows in a very general way, some of the many applications of computers and touches slightly upon their impact on society.

Below are extracts from the original Teacher's Guide for this film. (Reprinted through the courtesy of Union Carbide Corporation.) Additional notes have been inserted where appropriate.

Teaching Suggestions Before Viewing:

Jeremy Bernstein, author of The Analytical Engine, has defined the electronic computer as "an overgrown arithmetic machine" capable of addition, subtraction, multiplication, and division. The American Federation of Information Processing Societies, however, has stated that the computer is a tool "whose liberating potential for mankind is greater than that of any other invention in history" and has declared that "Our attempts to use this new tool to improve our world are limited only by our own imagination--and by the shortage of people who understand the computer."

Clyde E. Dankert of Darthmouth College has commented, "It may well be that history proves nothing, but it can at least suggest much. In view of this fact a useful purpose might be served if we consider the current problem of technological change against the background of opinions and developments of the past."

In the seventeenth century, a nineteen-year-old Frenchman named Blaise Pascal made the first significant advance toward the development of the modern computer since the invention of the abacus by constructing a machine that would perform additions mechanically.

What forces were in operation during the two thousand years prior to Pascal's invention that might have served to retard technological progress? Joseph Jacquard, in 1801, invented a loom that operated on instructions received from punched cards. Charles Babbage aided scientists and mathematicians immeasurably a hundred years later in their attempts to solve the technical and theoretical problems involved in the construction of a modern computer. The Census Machine, a mechanical tabulator created by Herman Hollerith, revolutionized census-taking in this country, setting a precedent for the use of computers to assume much of the burden of the bureaucratic paperwork that besets governments today.

In 1944, Howard H. Aiken built the first mechanical digital computer; two years later Aiken's machine was made suddenly obsolete by Dr. J. Presper Eckert, Jr. and Dr. John W. Mauchly, who had completed two and a half years of work on the construction of an electronic computer. Radical improvements in speed and productivity resulted from the substitution of electric circuits for mechanical parts. How has the introduction of "solid-state" logic and transistors, which replace the more bulky vacuum tubes of early models, served to further the computer's trend towards ultimate efficiency? What role does binary arithmetic play in the functioning of a computer? How do the four basic steps involved in computer operations--input, storage, processing, and output--correspond with the electro-chemical workings of the human brain and nervous system? In what ways might our knowledge of the "electronic brain" be applied to teach us more about the mystery of human thought processes?

Teaching Suggestions After Viewing:

The Wall Street Journal has reported that there were fewer than 1,000 computers in the U.S. in 1956. Computers now number over 40,000 in this country and the Radio Corporation of America has predicted that the U.S. will have 220,000 computers by the beginning of the twenty-first century.

Robert D. Tschirg, Dean of Academic Planning at the Berkeley campus of the University of California, has hailed the computer as "the greatest thing to hit education since Johann Gutenberg invented movable type."

"In the year 2,000 the U.S. farmer will be a sophisticated executive with a computer for a foreman," forcasts Thomas J. Bray.

An official of the Bureau of Public Roads has asserted that, before long "you'll see more emphasis on computers than concrete."

In what areas of manufacturing and production do computers now run entire assembly lines to insure accuracy and standardization? How has the ability of the computer to perform complex calculations at high speed proved invaluable to the National Aeronautics and Space Administration in its efforts to predict the probability of technical failures of machinery aboard space vehicles? How do huge computer networks now meet our needs for military defense? How are huge oil refineries "designed and tested" by electronic computers before the first piece of material is bought? How will centralized computer systems containing information about all residents expedite all municipal functions from crime prevention to welfare distribution? When will remote control of machinery in the home be available to the average housewife via electronic switching systems with computer controls? How will computers speed the transmission of mail in the future? How are they now performing bookkeeping tasks that would require armies of clerical workers in the nation's banks? regulating traffic at railroads and airports? designing highways? blueprinting bridges? How does the use of the computer to monitor the electrocardiogram readings of critically ill cardiac patients now allow doctors to respond instantly to any irregularity in the patient's pattern?

In what way does the use of a computer during operations permit doctors to analyze the trends of a patient's condition accurately and institute remedial measures quickly? How are computers, with their relatively unlimited memories, proving to be effective in taking over many of the administrative and supervisory functions of the staffs of hospitals? schools? factories? How do computers promise to revolutionize the study of law? access to the world's libraries? medical and biological research? What new discoveries have they recently made possible in the behavioral sciences? the basic questions of physics? astronomy? Do you agree with the conclusion of the National Commission on Technology, Automation, and Economic Progress that "through programs of research on human cognitive processes...it is not inconceivable that some day a physiological theory of learning will be proposed that may lead to the breaking of the input code and the direct input of factual information into human memory."?

"No stretching of the demonstrated technology is required to envision computer consoles installed in every home and connected to public utility computers through the telephone system," Professor John McCarthy of Stanford University has stated. "The console might consist of a typewriter keyboard and a television screen that can display text and pictures. Each subscriber will have his private file space in the computer that he can consult and alter any time. Given the availability of such equipment, it is impossible to recite more than a small fraction of the uses to which enterprising consumers will put it."

Paul Armer, head of the Rand Corporation's Computer Sciences Department, has stated that "Compared with the computers of a decade ago, today's machines are about 100 times faster, their electronic portions 10 times smaller and, most important, the cost of carrying out a given information-processing task is as much as 1,000 times less expensive. These advances will probably be matched in the next decade." James H. Binger, Chairman of the Board of Honeywell, Incorporated, believes that the computer "will be the propellant of the profound changes that contemplative men sense are soon to come."

How will the spiraling improvements in computer science serve to increase the availability of computers? What changes in the individual lives of the citizens of the twenty-first century do you think will result from the proliferation of computer equipment? How could the concept of "time-sharing," described by William D. Smith as the "simultaneous access by multiple users to a single large computer," be used to implement Professor McCarthy's theory of computer service as a "public utility"?

Glenn T. Seaborg, Chairman of the Atomic Energy Commission, has said that "the ultimate potential of the computer puts us to the test as human beings. It brings up questions we have lived with for centuries but never have been asked to answer fully, or act upon if we believed we knew the answers. It gives us new freedom and yet tremendous responsibilities which, if not acted upon, could result in a loss of almost all freedom. It presents us with choices and decisions of enormous consequences. It offers man a remarkable new chance to shape his own destiny, but asks him to be Godlike enough to select that destiny without much margin for error."

How do you believe modern man will meet that test?

THE COMPUTER REVOLUTION, PART II

Length and Type: 30 min., color, sound.

Source:

Summary: This film is one of the CBS "21st Century" series. It shows much better than Part I some of the current applications of computers, including modeling, income tax return processing, information retrieval, and speech synthesis. The sociological aspects of the widespread use of computers are touched upon briefly.

Below are extracts from the original Teacher's Guide for this film. (Reprinted through the courtesy of Union Carbide Corporation.) Additional notes have been inserted where appropriate.

Teaching Suggestions Before Viewing:

"The dominant factor in the modern world is the mastery, albeit incomplete, that technology has given us over the physical world," writes the Massachusetts Institute of Technology's Dean of Science, Jerome B. Wiesner. "The computer," he points out, "with its promise of a million-fold increase in man's capacity to handle information, will undoubtedly have the most far-reaching consequences of any contemporary technical development."

"The potential for good in the computer and the danger inherent in its misuse exceed our ability to imagine."

"If American society is to be as inventive as its technology," Michael Harrington, chairman of the board of the League for Industrial Democracy suggests, "it must move in radically new directions. Automation and cybernation have already fundamentally affected us--and they are going to bring even more thoroughgoing transformations in the future."

Among the advertisements that line the buses and subways of New York City's Transit System one reads: "When This Circuit Learns Your Job--What Are You Going To Do?" Whitney M. Young, Jr., Executive Director of the National Urban League, has commented that in the same year that ENIAC (Mauchly and Eckert's electronic computer) was completed, "the Employment Act of 1946 made the brave promise that the U.S. would provide 'a job for all those able, willing and seeking to work.' Barely a dozen years later the descendants of ENIAC were competing vigorously with men who were able, willing, and seeking to work."

Julius Rezler of Loyola University refers to "the process of alienation of the workers from their work" in a computer-dominated society.

List the ways you believe automation and cybernation have "already fundamentally affected us." Charles C. Killingsworth, University Professor of Labor Relations at Michigan State University, has noted that "technological developments of the past quarter-century, including automation, have gradually changed patterns of job opportunity," and that "there has been a growing lag in the adaptation of the labor force to these changed patterns...". Do you agree with Professor Killingsworth that "large-scale computer installations appear to have their greatest displacement impact on the lowest-level, most routine clerical jobs."? Only through the "expansion and strengthening of our education and training efforts," can we hope "to promote economic growth and full employment..."

The Wall Street Journal reports that "Computer makers themselves note that their industry has created some 250,000 new jobs and that the total will grow."

In answering the charge that productivity advance fostered by technological improvements is a major cause of unemployment Stanley Lebergott, Professor of Economics at Wesleyan University, reminds us that, "Few cries of joy would greet a proposal that American workers begin putting in a 16-hour day to pay for the goods and services they now can buy with 8 hours of work. Yet this is precisely the result that would follow if productivity advance had been stopped as recently as 1940. For since that year our output per man-hour has just about doubled: in one 8-hour day we now produce twice the amount we used to." Professor Lebergott has hailed the destruction of arduous and uninteresting jobs as the mark of a progressive society, saying that "we must recognize that we should want productivity advance to destroy jobs--to increase the amount of time, attention, and energy human beings could devote to other things in life than working for pay."

Glenn T. Seaborg points out: "A civilization equipped and educated to live in an era of relative leisure can bring about a new Golden Age--one without a slave base, other than those mechanical and cybernetic slaves produced by the ingenuity of a higher level of man. Such an age does not have to be, as a few predict, a civilization of drugged, purposeless people controlled by a small elite. But it could tragically become that, if we did nothing but let ourselves be swept along by some of the forces in motion today."

An editorial in The Hartford Times voices the fear that the computer, with its virtually inexhaustible capacity for processing and storing information, may be a threat to the privacy of the individual. In the city of New Haven a central computer is soon to handle the records of all municipal functions: "There are hazards," The Hartford Times points out, "in the centralization and availability of information. It is no proper business of the city engineering department, for example, that a certain man was out of work and was supported by the welfare department during the Depression. The privacy of individuals must be safeguarded."

Representative Cornelius F. Gallagher of New Jersey in examining a proposed national data center, has warned that "We cannot be certain that such dossiers would always be used by benevolent people for benevolent purposes."

To Lester Wunderman, President of Wunderman, Ricotta, and Kline, the new technology, however, heralds an age of "repersonalization" rather than "depersonalization." "People, products, and services are all seeking an individual identity," he has observed. "Automation, which we feared as being anti-people, has become pro-person."

"Our automated, computerized, electronic, information society has created opportunities for personalized, individualized selling, which will surely replace mass marketing.

"A computer can know and remember as much marketing detail about 200,000,000 consumers as did the owner of a crossroads general store about his handful of customers."

"Our national economy is marked by an insatiable thirst for energy," Carl E. Reistel, Jr., a former Chairman of the Board of the Humble Oil and Refining Company, has said. By the beginning of the twenty-first century, it has been estimated that the gross national product of the U.S. will be in excess of 4 trillion dollars, about five times higher than the present. James H. Binger, Chairman of the Board of Honeywell, Incorporated, has said of the coming era that the computer "will be the economic force--the power plant of productivity."

"There is no doubt that the Cybernetic Revolution is going to make us re-examine the relationships between our freedoms and our responsibilities within the framework of society and find ways to guarantee a maximum of freedom for the individual within a highly organized society," Glenn T. Seaborg, chairman of the Atomic Energy Commission, has stated. The challenge, as Dr. Seaborg puts it, lies in "living with and using the complex machines of the future in a human-oriented society."

What functions would you like to see taken over by twenty-first century computers? How might computers place the knowledge of the entire world at the fingertips of every man? design whole cities? predict the resources of an unexplored planet? the potential of an unborn child? Do you believe that computers will make it possible to map the though processes and unlock the mysteries of the human mind? Man has learned to use the microscope and the telescope, radio and television, radar and sonar to extend the powers of the senses he was born with. How might he be able to use the computer to further extend the powers of his mind? What problems would you like to see the computer solve as an extension of the mind of man?

LESSON 9

Objectives: I. To review major ideas in computer programing using the BASIC language.

II. To review major ideas associated with the computer's historical development, applications, and impact on society.

Activities: I. Have students working in groups of 3 complete Review Test 2. Make a tape of the answers and call Program CORCT2 to correct the questions.

II. Have a small group discussion on computers and computer programming.

LESSON 10

Objectives: To determine if students have met the objectives of the computer unit.

Activities: Distribute test to students. For example test, see below.

Computer Unit Final Evaluation	Students Name ____________ Evaluator ____________	☐ Total Points	☐ Grade

I. Computer Programming
A student writes two programs - one required and one optional.

a) Can the student draw a flow diagram? ☐ Yes ☐ ☐ No
b) Can the student write a BASIC program? ☐ Yes ☐ ☐ No
c) Can the student trace the program? ☐ Yes ☐ ☐ No

II. Terminal Operation
Each student operates the terminal for approximately 5 minutes

a) Can this student make a paper tape? ○—○—○
Yes No

b) Can this student turn the terminal on and log in properly? ○—○—○
Yes No

c) Can this student load a tape into the terminal? ○—○—○
Yes No

d) Can this student correct a line in a program? ○—○—○
Yes No

e) Can this student use the commands RUN, SAVE, KILL, GET, and LIST? ○—○—○
Yes No

f) Can this student sign off the computer? ○—○—○
Yes No

III. Discuss briefly your reactions to the statement:

> Personal data banks will help create a more effective government by eliminating favortism in important decisions.

LESSON 11

Objective: To discuss with students their individual growth in this unit.

Activities: I. Complete group score board (see next page)

II. Grade student papers and programs.

III. Discuss with each student his progress and grade in the unit.

IV. Have each student fill out a feedback form.

GROUP SCORE BOARD

Name	Computer Programs (5 pts. each)								Abstracts (5 pts. each)					Group Discussion (25 max.)	Impact Paper (30 max.)	Eval. (50 max.)	Total Points (170)
									#1	2	3	4	5				

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Computing Surveys
Journal of the ACM
Subcommittee Publications

UNIT: THE ENVIRONMENTAL CRISIS

Sub-problem: The Population Explosion, Man's Self-Destruction, Cities of the Future.

Objectives: I. To be aware of the environmental problem.

II. To be aware of the factors influencing the problem.

III. To be aware of point of view concerning the problem.

IV. To be aware of the problem in the past.

V. To be aware of proposals to deal with the problem.

VI. To be aware of unanswered questions.

VII. To do extensive research on the problem in terms of the above objectives.

Activities: I. To prepare a written report on the problem using the following outline:

- A. Environmental Problem
- B. Factors Influencing this Problem
- C. Points of View Concerning the Problem
- D. The Problem in the Past
- E. Proposals to Deal with the Problem
- F. Unanswered Questions

II. To give a presentation on the problem to the class.

III. Guest speaker(s) on problem.

IV. Field trip to investigate problem.

V. Film strips and movies on problem.

VI. Required reading on problem.

THE EVIRONMENTAL CRISES

This unit includes two problem areas; Man's Self-Destruction; and The Population Explosion. Each unit will be three weeks in length. In each unit, the class will be divided into four groups each of which will study a specific problem in the general area. The specific problems for each unit follows:

I. Man's Self-Destruction

  A. Wildlife Extinction--Is it reaching Colorado?

  B. Deterioration of Water Quality and Resources in Colorado.

  C. The Extended Use of Air-Polluting Fuels--both beneficial and harmful to the problem.

  D. Insecticides, Nitrogen Fertilizers, Dam Building, Nuclear Power--both beneficial and harmful to the problem.

II. The Population Explosion

  A. The extend to which over-population is causing destruction of natural resources.

  B. The legal and moral aspects of controlling population.

  C. Is it possible to adequately feed the expanding population.

  D. The Education of Society on population control.

DESCRIPTION OF ACTIVITIES: POPULATION EXPLOSION

1. Outline on which written report is based:

   A. Environmental Problem
   (The accelerating rate of population growth.)
   B. Factors Influencing this Problem
   (People are living longer due to advances in medicine; disease and war control; religious opposition to birth control, abortion, etc; the increasing percentage of people under age 15 in the world.)
   C. Points of View Concerning the Problem
   (The varying viewpoints of authorities and institutions concerning the problem.)
   D. The Problem in the Past
   (An investigation of early population growth up to and including the recent accelaration.)
   E. Proposals to Deal with the Problem
   (A study of the merits of current and proposed programs dealing with population control.)
   F. Unanswered Questions

2. **Guest Speakers:**
   Speakers on population control

   A. The pros and cons of legally limiting the size of families.
   B. The pros and cons of abortion laws.
   C. The methods of birth control.
   D. The religious connotations of birth control.
   E. The relation between overpopulation and the other environmental problems.

3. **Field Trips:**

   Field trips to agencies which deal with population control.

4. **Filmstrips and movies which deal with the population explosion:**

   A. Crisis of the Environment, Part V
   The New York Times Educational Division
   B. Standing Room Only
   C. Beyond Conception

DESCRIPTION OF ACTIVITIES: POPULATION EXPLOSION (cont.)

5. Required Reading:

THE POPULATION BOMB, by Dr. Paul R. Ehrlich, Ballantine, 1968.

6. Suggested Reading:

POPULATION IN PERSPECTIVE, edited by Louise B. Young, Oxford, 1968.
STANDING ROOM ONLY, by Karl Sax, Beacon Press, 1967.
1976: AGENDA FOR TOMORROW, by Stewart L. Udall, Harcourt, Brace, 1968.
FAMINE--1975! by William and Paul Paddock, Little Brown, 1964.
THE SILENT EXPLOSION, by Philip Appleman. Beacon Press, 1965.
THE HUNGRY PLANET, by Georg Borgstrom. Collier Books, 1967.
TOO MANY AMERICANS, by Lincoln H. Day and Alice Taylor Day, Delta Press, Inc., 1965.
THE POPULATION DILEMMA, by Philip M. Hauser, Prentice-Hall, 1963.
ABORTION AND THE LAW, by David Lowe, Pocket Books, 1966.
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THE POPULATION CRISIS, edited by Larry K. Y. Ng and Stuart Mudd, Indiana University Press, 1965.
POPULATION PROBLEMS, by Warren S. Thompson and David T. Lewis, McGraw-Hill, 1965.
DR. GUTTMACHER IS THE EVANGELIST OF BIRTH CONTROL, by David Dempsey, The New York Times Magazine, February 9, 1969. p. 32.
POPULATION BULLETIN, Population Reference Bureau, Inc., 1755 Massachusetts Avenue, N.W. Washington, D.C., 20036.
Current newspaper and magazine articles on the population problem.

DESCRIPTION OF ACTIVITIES: MAN'S SELF-DESTRUCTION

1. Outline on which written report is based:

   A. Environmental Problem
   (The destruction of the ecology of the earth.)
   B. Factors Influencing this Problem
   (Air, water, thermal land and noise pollution of the environment.)
   C. Points of View Concerning the Problem
   (The varying viewpoints of authorities on the extent of the problem.)
   D. The Problem in the Past
   (An investigation of early ecological destruction up to and including the recent acceleration.)
   E. Proposals to Deal with the Problem
   (A study of the merits of current and proposed programs dealing with pollution control.)
   F. Unanswered Questions.

2. Guest Speakers:
   Speakers on pollution control

   A. Legislators and/or representatives of governmental agencies.
   B. Representatives from industry.
   C. Representatives of concerned groups.
   D. Student debate on federal control, administration, and financing of pollution control programs.

3. Field Trips:

   Field trips to industries in the area and/or pollution monitoring stations. A tour of the school and campus area.

4. Filmstrips and movies which deal with the pollution problem:

   A. The Run Around
   B. Crisis of the Environment Series, Parts I-IV.

DESCRIPTION OF ACTIVITIES: MAN'S SELF-DESTRUCTION (cont.)

5. Required Reading:

SILENT SPRING, by Rachael Carson.
SINCE SILENT SPRING, by Frank Graham, Jr.

6. Suggested Reading:

THE ENVIRONMENTAL HANDBOOK, Garrett DeBell.
THE FRAIL OCEAN, Wesley Marx.
MOMENT IN THE SUN, A report on the deteriorating quality of American Environment.
S/S/T AND SONIC BOOM HANDBOOK, William Shurcliff.
PERILS OF THE PEACEFUL ATOM, Curtis and Hogan.
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MAN'S ROLE IN CHANGING THE FACE OF THE EARTH, edited by W. L. Thomas, University of Chicago Press, 1956.
THE BALANCE OF NATURE, by Lorus and Margery Milne, Knopf, 1960.
THE MEANING OF WILDERNESS TO SCIENCE, edited by David Brower, Sierra Club, 1960.
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DESCRIPTION OF ACTIVITIES: MAN'S SELF-DESTRUCTION (cont.)

6. Suggested Reading (cont.):

THE QUIET CRISIS, by Stewart Udall, Avon, 1967.
CONSERVATION: Now or Never, by Nicholas Roosevalt, Dodd, Mead, 1969.
AMERICA THE RAPED, by Gene Marine, Simon and Shuster, 1969.
LAND, WOOD AND WATER, by Robert Kerr, Macfadden-Capitol Hill 1963.
BEAUTY FOR AMERICA, Proceedings of The White House Conference on Natural Beauty, U.S. Government Printing Office, 1965.
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BEFORE NATURE DIES, by Jean Dorst, Houghton Mifflin, 1969.
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UNIT: MAN-MACHINE INTERACTION

Objectives:

I. The student will learn the meaning of the term "technology."

II. The student will answer the question, "Why did modern technology develop in the West rather than in the Orient?

III. The student will discover the ways in which society has in the past reacted to new technological advances.

IV. The student will investigate the ways in which technology affects contemporary society.

V. The student will investigate the ways in which technology may affect society in the future.

Activities:

I. The student will engage in reading and discussion to learn the meaning of the word "technology."

II. The student will engage in reading and discussion with other students to answer the question, "Why did modern technology develop in the West rather than in the Orient?

III. The student will engage in reading and discussion to discover the ways in which society has in the past reacted to new technology.

IV. The student will engage in reading and discussion to investigate the ways in which technology affects contemporary society.

V. The student will engage in reading and discussion to investigate the ways in which technology may affect society in the future.

VI. The student will communicate his answers to these questions by way of a written report.

Evaluation:

I. The student did engage in reading and discussion.

II. The student did prepare a written report.

I. What is technology?

The word "technology" is heard with increasing frequency in our society. For example, in a recent edition of a popular magazine the word was used 78 times by several authors writing on diverse subjects. Indeed, some observers have spoken of society as a "technological civilization."

In the light of this, your first assignment is easy to state:

1. Define the meaning of the word "technology." Do not rely on a dictionary definition alone. Use any and all resources available to define the word.

II. Why did modern technology develop in the West rather than in the Orient?
Stating the problem:

Technology is as old as man himself. Scholars have told us that the earliest specimens of homo sapiens used tools to make life easier and better. These early men chipped rocks to make jagged edges to be used in killing animals more easily or in defending themselves. Later they used sharpened stones to skin animals for clothing or shelter.

As time passed man began to develop more advanced forms of technology. The Egyptians utilized various tools to build gigantic pyramids. At Stonghange, in England, men moved rocks, weighing many tons, hundreds of miles and set them in an up-right position to create a structure which, apparently, had some religious significance.

For thousands of years Western Europe was a place of barbarism in comparison with the advanced civilizations in Sumeria, Egypt, India and China. Most historians believe that as late as the Middle Ages the Moslem Civilization in the Middle East was in many ways superior to that of Europe.

But by the 17th, 18th, and 19th centuries, the situation had been reversed. The "backward" Europeans had begun to develop technology to such an extent that a geographically and numerically small area was able to dominate vast sections of the world. Tiny Great Britain was able to conquer India and humiliate China. By the 19th century, Europe had come to dominate much of Africa, (where the earliest fossil remains of man have been found), the Far East and the Middle East. Consider the following illustrations:

> Gunpowder was apparently invented in China. Yet it was the Europeans who harnessed it to create awesome weapons.
>
> Printing was also invented in China. But the Europeans used the invention to produce a torrent of written material.
>
> Ancient Egyptians apparently knew something about brain surgery. But advanced surgical techniques have been created in the West only within the last century.

Thus, the basic problem that confronts us is why the Orient with its ancient cultures and knowledge did not develop technology to as sophisticated a degree as did the West. Why, even in the 20th century are the non-western nations referred to as "under-developed nations"?

III. What are the ways in which society has in the past reacted to new technological advances?
Stating the problem:

In Great Britain in the late 18th century and early 19th century the Industrial Revolution resulted in the invention of many labor-saving machines. A prime example is the invention of new types of weaving and knitting machines. There was a general fear on the part of weavers that unemployment would result from the introduction of these machines. When unemployment did in fact result, the weavers reacted by smashing the offending machinery. Between March, 1811 and February, 1812, 1000 machines were smashed in spite of the fact that law had been passed making machine breaking a capital offense. Violence was directed against persons as well as machines. In 1813, a manufacturer was murdered by three men who were part of an organization known as "Luddites." The Luddites had organized with the express purpose of protecting their jobs in the face of technological advances.

They clearly state their purpose in the following letter:

> "We will never lay down Arms till the House of Commons
> passes an Act to put down all Machines hurtful to Commonality,
> and repeal that to hang Frame Breakers. But we, we petition
> no more--that won't do--fighting must.
> Signed by the General of the Army of Redressers.
> Ned Ludd Clerk
> Redressers for ever Amen."

Questions:

1. Is this the way in which society has usually reacted to innovations?

2. What might have been done to prevent violence in a situation such as the one described above?

IV. How does technology affect contemporary society?
Stating the problem:

A. Technology and Unemployment

In recent years the coal industry has developed, "The Push-Button Miner." This device stands three stories high and weights more than 1½ million pounds. It can cut and load 266 tons of coal per hour and is operated by three men in a remote control center outside of the mine shaft.

Devices such as this have tripled the amount of coal which can be mined in one day and have made the American coal industry the most efficient in the world. However, this efficiency has been attained at some cost; in 1966 coal mining employment was about 75% less than what it was in 1948.

A similar story could be told about American agriculture. Beyond a doubt, it is the most efficient in the world. Fertilizers, weed killers, insecticides and new machines have tripled farm output since 1947.

Mechanical cotton pickers harvest more than 90% of the cotton crop and they do it more cheaply then men paid as little as $6 per day. Millions of farm workers have been displaced by machines. This problem seems to have hit Negroes the hardest. Thousands of Negroes have been left poor and hungry with the only escape being the prospect of moving to a big city slum.

B. Machines and Man: Capabilities

Take a deck of ordinary playing cards. Shuffle them and then sort them into the four suits and into the sequence of numbers from two through ace. Time yourself to see how long it takes you to perform this operation. How many errors did you have to correct?

When you have timed yourself and estimated the number of errors consider the following:

> Some banks have a check sorting machine which sorts checks at the rate of 1,800 checks per minute with virtually no errors.
>
> A high speed computer can perform at a rate of 100,000 operations per second for one week before there is a 50% chance of one error.

Questions:

1. Must automation necessarily result in an increase in unemployment?
2. What types of tasks can machines perform better then men?
3. In what ways may society benefit from the uses of technology?

V. Technology and The Future

Stating the problem:

A. Some futurists (persons who try to predict what the future will be like) forecast that by the 21st century the average work week will be much less than what it is now. They believe that the average person may work 10-15 hours per week in contrast with the present 35-40 hour work week. Some futurists even go so far as to predict that all goods and services will be produced by non-human means. That is, the average man will have practically unlimited leisure time except for minor maintenance of machines.

B. There is some speculation that in the near future data banks will be created by some government agency. These data banks will contain every bit of information known about every person in the United States. Who will have access to this information? How will the information be used? These, and other questions, have not yet been answered.

Questions:

1. If work is largely eliminated, how will man spend his time? Can man exist without work?

2. Do you think that government operated data banks are good?

Conclusion:

Your answers to the questions in Sections I-V should be discussed, researched and put in the form of a written report. Be prepared to discuss your answers with other students and with the teachers.

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UNIT: LABOR VS. MANAGEMENT SIMULATION

Objectives:

I. The student will make decisions which will resolve the issues in dispute.

II. The student will communicate his decisions to other students.

III. The student will analyze the ways in which conflict may be resolved.

Activities:

I. The student will engage in research to serve as the basis for his decisions.

II. The student will engage in negotiations and discussion with other students.

III. The student will write a brief paper on how he believes conflict may be resolved.

Evaluation:

I. The student did the research called for.

II. The student did communicate his decisions both orally and in writing.

III. The student did write a brief paper.

LABOR VS. MANAGEMENT UNIT

In this simulation activity students are assigned to various roles. They are provided with detailed information concerning the community in which they live and the nature of the present labor-management dispute. It is the responsibility of the students to resolve the dispute as best they can.

There seem to be three major objectives inherent in this activity:

A. To give the student greater facility with the decision-making process and feed-back.
B. To make the student aware of the interaction between society and technology.
C. To improve the process of communication.

I. Scenario

We are all citizens of Pleasant View, a city of about 36,000 people. Until recently our city has been happy and relatively free of tensions. We have worked together and taken great pride in our city; especially in the high school basketball team which has won the state championship five times in the last eight years.

Our largest local industry is the manufacture of translumps--a key item in the electronics industry. Right here in Pleasant View, we have the main plant and head office of the Acme Translump Manufacturing Company. The factory employs 6,000 workers all of whom are members of the United Translump Workers of America. Until now, the workers have been contented and prosperous.

About a week ago, however, troubles began to develop. Contract negotiations between the union and management broke down. Production has stopped, pickets parade around the plant, and the entire economic welfare of the community is threatened.

/

LABOR VS. MANAGEMENT UNIT (cont.)

The news media has focused on this crisis and the eyes of the nation are on us. We have heard many rumors and tempers are increasingly frayed. A sober analysis of the crisis show that there are three general areas of dispute:

A. Hourly Wages.

Present Rate: $2.25 per hour. Time and a half after 40 hours.
Union Proposal: $2.60 per hour. Double time after 40 hours.
Last Company Offer: $2.35 per hour. Time and a half after 40 hours.

B. Paid Vacations and Sick Leave.

Present Plan: Two weeks per year. Five days paid sick leave.
Union Proposal: Four weeks per year. Ten days paid sick leave.
Last Company Offer: Three weeks per year. Five days paid sick leave.

C. Prospective Layoffs In View of the Coming of Automation.

1. It is known that the company plans technical changes using automated methods that will make it possible to reduce its labor force by about 2,000 or more employees sometime within the next six months.
2. The union is asking that seniority be the basis on which employees will be retained; last employed, first laid off. (Also, the union asks that 3 three months severance pay be given to each employee with more than two years service who is laid off.)
3. So far, the company has not agreed to either of these proposals. This may prove to be the biggest block in the way of a compromise settlement.

For several days neither side has been communicating in any way with the other. Because of the serious impact of this kind of a dispute on the total economic well-being of the city, the Chamber of Commerce and the Mayor's office both have taken steps to enter the picture.

The question which both groups are now pondering is, "What can we do to bring labor and management together and work out a fair solution to the problem?" Finally, remember that in this land of a dispute, press releases can be either helpful or damaging so all parties should give careful consideration to any statement made to the news media.

II. Given this background students will be assigned to the following roles:

A. Labor
B. Management
C. Chamber of Commerce
D. City Council
E. News media

As negotiations proceed students will begin to see the importance of making decisions based upon realistic and adequate information. They will also see how decisions sometimes have unexpected consequences. Second, in order to resolve this dispute there must be good communication among the participants. Thirdly, students will begin to experience for themselves how important and emotional an issue as automation can become. That is, the interaction between society and technology can frequently be accompanied by tension and apprehension.

III. Evaluation

One of the crucial questions involved in the use of simulation exercises is that of evaluating the performance of the individual student. In terms of this particular simulation the following criteria are advanced:

LABOR VS. MANAGEMENT UNIT (cont.)

A. Has the student contributed to the solution to the problem? This may be determined through observation by the teachers and by fellow students.
B. Before the unit has been introduced each student will be asked to write an answer to the question, "How can conflict between individuals and groups be resolved?" At the conclusion of the unit each student will be asked to write another answer to the same question. The two answers will then be compared to determine whether or not the student has become more perceptive and sophisticated in relation to this question.

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Special Note

This simulation exercise is an adaptation of "Labor vs. Management: A Simulation Game" written by John D. Gearon, High School Social Studies Consultant in the Chicago Public School System. Mr. Gearon's article describing this game appeared in, "Social Education," the October, 1966 issue.

MANAGEMENT--CONFIDENTIAL DATA

Sales Record--last fiscal year--$100 million.

Profits--last fiscal year--(after taxes, dividends, salaries, over-head, etc.)
10% or $10 million.

Savings--$14 million. Most invested in stocks, bonds.

The cost of the union proposals: (Estimated)

A. Hourly Wages.
This cost is estimated to be ______________.

B. Paid Vacations and Sick Leave.
This cost is estimated to be ______________.

C. Automation.

1. A reduction of the labor force by 2,000 will reduce the company payroll by 1/3 and will save on salaries in the long run.
2. The initial cost of automation will be fairly high: Approximately $10 million.
3. It is difficult to estimate the cost of the union proposal. It is known that of the 2,000 employees who will be laid off that 1,500 have been employed for more than two years. Figuring the monthly salary of these employees (at the present hourly rates) and multiplying the monthly rate by three months and then by 1,500 gives the rate of ______________.

Management realizes that a large increase in wages and benefits could result in one or more of the following alternatives:

A. A reduction of profits.

B. An increase in the cost of translumps to consumers. How would this affect your sales position relative to your competitors?

C. Profits could remain constant if the same number of employees working the same number of hours could produce a larger quantity of translumps.

C. Could this result in a surplus of translumps on the market? How might a surplus affect sales and profits?

UNION: CONFIDENTIAL DATA

I. Loyalty of Union Members.

A great number of your members are in firm support of the strike although several hundred workers seem to be satisfied with the present wages and benefits. Most members feel that higher wages, longer paid vacations and more sick leave days are necessary to keep pace with the cost of living. The average annual rate of inflation is 7% and your wages must keep pace with this inflation. To protect yourselves the issue of automation must be resolved to your satisfaction.

II. Strike Fund.

Your union dues are $5.00 per month per person, or 6,000 workers times $5.00 is a total of $30,000 monthly. Of this total $10,000 is spent for various expenses, leaving a balance of $20,000 per month. For sometime you have anticipated a strike and your strike fund is now $1.4 million. This fund can be used to compensate workers while they are on strike. You should calculate how long you can pay workers their full salary with this amount. The strike fund will last ________________ weeks.

UNIT: MAJOR URBAN PROBLEMS

This unit may encompass as many problems as time permits. This year City Planning in the Denver Area will be studied in a unit entitled, "Cities of the Future." The class will be divided into four groups each of which will study a specific problem in the general area. The following is a list of the four problems: Design for Denver in the year 2,000; The destruction of natural resources by the increase of the size of cities (sign clutter, highway builders, more parking lots, fewer recreational facilities.); Transprotation in Denver in the year 2,000; Building standards, zoning laws, type of family dwelling in the future.

DESCRIPTION OF ACTIVITIES: CITIES OF THE FUTURE

1. Outline

   A. Environmental Problem
      (Zoning laws, urban sprawl, megalopolis, ghetto areas, low income housing, ecological destruction, etc.)
   B. Factors Influencing this Problem
      (Public apathy, zoning laws, special interests, flight from the city, financing, transportation, inadequate planning, etc.)
   C. Points of View Concerning the Problem
      (The varying viewpoints of authorities on the causes and solutions of the problem.)
   D. The Problem in the Past
      (An investigation of early urban growth, and the evolution of the problem.)
   E. Proposals to Deal with the Problem
      (A study of the merits of current and proposed programs dealing with urban growth and the applying of this knowledge to the Denver area.)
   F. Unanswered Questions

2. Guest Speakers and/or Panel Discussions:
   Speakers on city planning

   A. Representatives from governmental agencies dealing with city planning.

      1. Denver urban renewal
      2. Denver model cities program
      3. Denver planning office
      4. Denver Regional Council of Governments

   B. Representatives form citizen groups concerned about city planning.

      1. Civic association leaders
      2.
      3.

3. Field Trip(s):

   Field Trip(s) to planning offices and to the area under study.

DESCRIPTION OF ACTIVITIES: CITIES OF THE FUTURE (cont.)

4. Related Movie:

Cities of the Future

5. Required Reading:

6. Suggested Reading

THE CITY IS THE FRONTIER, by Charles Abrams, Harper, 1965.
GOD'S OWN JUNKYARD, by Peter Blake, Holt, 1964.
CITY & SUBURB, by B. Chinitz, Prentice-Hall, 1964.
SICK CITIES, by Mitchell Gordon, Macmillan, 1963
MEGALOPOLIS, by J. Gottmann, Twentieth Century, 1961.
HEART OF OUR CITIES, by Victor Gruen, Simon & Shuster, 1964.
THE METROPOLITAN PROBLEM & AMERICAN IDEAS, by L. H. Gulick Knopf, 1962.
THE SQUEEZE: CITIES WITHOUT SPACE, by E. Higbee, Morrow, 1960.
URBAN LIFE & FORM, by W. Z. Hirsch, Holt, 1963.
DEATH & LIFE OF GREAT AMERICAN CITIES, by Jane Jacobs, Random House, 1961.
IMAGE OF THE CITY, by Kevin Lynch, Massachusetts Institute Of Technology, 1960.
FACE OF THE METROPOLIS, Martin Myerson, Random House, 1963.
CITY IN HISTORY, Lewis Mumford, Harcourt, 1961; CULTURE OF CITIES, Harcourt, Brace & World, 1938.
*PLANNING OUR TOWN, by Martha Munzer, Knopf, 1964.
CITIES, by Scientific American, Knopf, 1965.
CHALLANGE OF MEGALOPOLIS, by Wolf Von Eckardt, Macmillan, 1964.
DILEMMAS OF URBAN AMERICA, by Robert C. Weaver, Harvard University Press, 1965.

*Easy reading

Evaluation

I. The student developed an awareness of the environmental problem.

II. The student developed an awareness of the factors influencing the problem.

III. The student developed an awareness of the points of view concerning the problem.

IV. The student developed an awareness of the problem in the past.

V. The student developed an awareness of the proposals to deal with the problem.

VI. The student developed an awareness of the problems still unanswered that deal with the problem.

VII. The student did extensive research on the problem which is evidenced by the written report.

VIII. The students gave a presentation on the problem to the class.

IX. The students heard guest speakers discuss the problem.

X. The students went on field trips to investigate the problem.

XI. The students saw filmstrips and movies related to the problem.

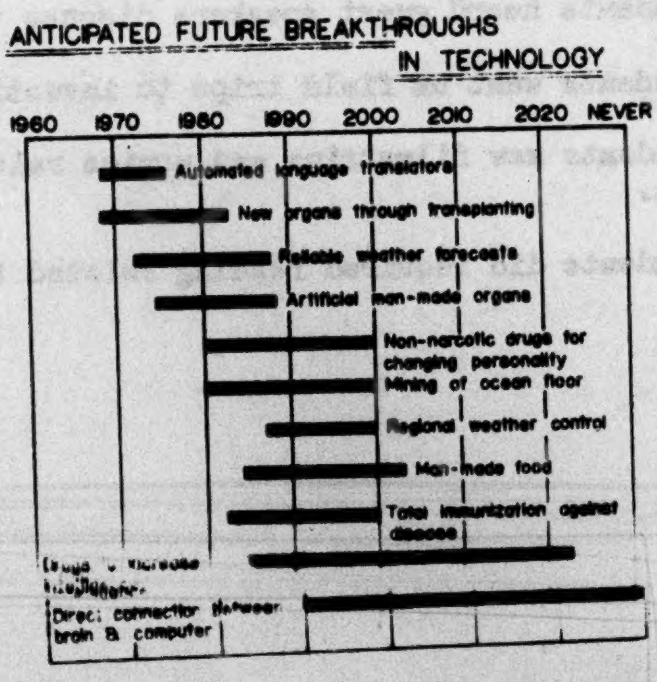
XII. The students did required reading related to the problem.

THE YEAR 2000
or
(Bumbling Along With Humanity)

Introduction

The chart below indicates some of the anticipated future breakthrough in technology. Some of them may seem desirable to you and others may seem threatening. You most certainly will be call upon to approve or disapprove some of them in the near future. Each of these changes will have a tremendous effect either directly or indirectly on all people living in the year 2000--if humanity survives to that date--implications that are social and moral as well as technological.

Notice that all of the predicted changes start within the next 20 years.



If one couples the above mentioned facts with the fact that today's high school students will be in positions of responsibility in the year 2000, a time when the United States will include 14 cities the size of New York City today--

each one confronting problems of traffic control, slum clearance, ethnic integration, pollution and all the other problems that go along with life in a major megalopolis--one begins to realize that students will have to possess some knowledge of technology and the future if they are to make the type of decisions that will enable man to successfully live in these kinds of situations.

The purpose of this unit is to try to look into the future and anticipate some of the changes that are going to happen and based upon what we see to try to determine how we might best prepare for what is to come. The future cannot be predicted, the experts tell us, but it can be beneficially determined if people can be shown what their own best interests are and then collectively decide what they want the world of tomorrow to be. Our future may lie beyond our vision, but it is not completely beyond our control. It is our hope that previous material studied in this course plus what you learn in this unit will enable you to play a more meaningful role in determining the future and that many of you will soon be able to say as is paraphrased here from George Bernard Shaw:

> Some people see things as they are and ask why.
> I dream things that never were and ask why not.

Objectives:

I. To examine part of our recent past as basis for improving our ability to look into the future.

II. To reevaluate some of the present sociological and ecological problems that have been treated in this course and use this knowledge for extrapolating into the future.

III. To study various documents produced by experts in the field of future prediction.

IV. To combine knowledge of history, present problems and the opinion of experts into our own prediction of what the future may hold for the year 2000.

V. To pit our predictions of the future against those of the experts (Kaiser Aluminum) as a means of testing their validity value.

VI. To try to determine what our present national priorities are and based upon our personal philosophy and knowledge of what the future may hold list what our national priorities ought to be.

Plan of Attack: There are various ways to look into the future, some more complicated than others. The more complicated methods involve mathematical equations and models--computer simulations. Because of time limitations, we choose a somewhat easier route, but hopefully the result will be just as fascinating. Our attack involves a look into our recent past to try to discover trends, an examination of our present state so that we might better anticipate our future needs, an examination of the experts predictions to better understand why they feel the way they do and finally a matching of our views against those of the experts in a future simulation game--a game which closely resembles the prediction models created in the world's most sophisticated computers. After these experiences, each of you will certainly have ideas as to how man might best prepare for the year 2000. The final stop will be to formulate a list of national priorities we might set today to better prepare us, as a people, for what is to come.

Description of the Unit:

A. An examination of our recent past. In this section you are to examine the period from 1900-1970 in light of the items listed on the chart. Complete the chart by listing, in the box provided, the information on that time period (centered around the indicated year) concerning the indicated item. To help you in your study examine the following materials:

1. The Children of Change
   by Don Fabun
   pages 18-21

2. This Fabulous Century Vol. 1-6.
   (1900-1960)
   by Time-Life, Inc.
   Each volume covers a ten year period and begins with a brief summary of the decade under consideration.

You are encouraged to seek out any other materials which will aid you in this assignment. Before going on to the next step, each group is to turn in the completed chart.

A LOOK BACK

Item	1900	1920	1940	1960	1970...	2000
standing racteristic this time						?
Major Problem(s)						?
aracteristic titudes						?
ninant world wers						?
Foreign olicy						?
ninant gure						?
Population						?
re people lived rban or rural)						?
ajor cupations						?
Work week						?
hourly wage						?
e index 29 = 100)						?
uctivity/man hr. 929 = 100)						?
GNP						?
autos istered						?
telephones						?
radio sets						?
TV sets						?
life pectancy						?
ding causes death						?
size of amily						?
of the sexes the youth						?

B. **An Examination of Our Present Situation:**

So far in this course, you have examined how people interact with each other, how nations interact and the problems of population growth, pollution, automation, and city design. Reexamine these topics in terms of how an understanding of them can help you predict what the future may hold.

Before going on to the next step, each group is to turn in their completed chart.

Item	Apparent Trends
man-to-man interaction	
man machine interaction	
nation-to-nation interaction	
population growth	
pollution	
transportation	
city design	

The Expert's Viewpoint:

In this section, you are to do the following:

A. Answer the question: "Who are the futurists?"
B. Read the book: "Footnotes on the Future" by John Kettle.
C. View the 21st Century film: "The Futurists"
D. Examine as many of the following materials as you can. Much of this material is very well done. Do not underestimate these items.

1. Book: "The Dynamics of Change" by Don Fabun--a penetrating examination of the Future and the behavioral changes necessary as we move into it.
2. Publication: Kaiser News, "The Markets of Change" Series a six part series exploring some of the technological responses that may be made in the next 30 years to the behavioral changes described in "The Dynamics of Change" Published by the Kaiser Aluminum and Chemical Corporation.
3. Publication: The Futurist--the bimonthly (6 times year) publication of the World Future Society: An Association for the Study of Alternative Futures.
4. Tape recording: "Models for the Future."--this tape contains an interview with Robert Jungk, Founder of Mankind 2000 International in Vienna.
5. Book: "Here Comes Tomorrow"--a collection of articles on the Future that appeared in the Wall Street Journal.
6. Chart: "Chart of the Future"--a chart of past, present, and predicted future developments in technological areas by Arthur C. Clarke-British scientist and science-fiction writer.
7. Book: "The Year 2000"--Demonstrating the new techniques of the think tanks, this book projects what our own world most probably will be like a generation from now--and gives alternatives.

In light of your examination of the above materials, fill in the column of the chart below which is entitled "Expert's opinion." Whenever possible, rate the likelihood of the event occurring in %-probability.

FORECASTING THE YEAR 2000

ITEM	EXPERT'S OPINION	YOUR OPINION
1. Effective world-wide fertility control is practiced		
2. 3 out of 4 people in U.S. live in cities or towns		
3. Most urban people live in high-rise multi-use buildings		
4. Computer programmed use of all agricultural land areas in intro.		
5. World crop loss is drastically reduced.		
6. Substantial increase in food supply is obtained through ocean farming		
7. Economic production of fresh water from oceans is possible world-wide.		
8. Air and water pollution are controlled.		
9. Private passanger vehicles are barred from most city cores.		
10. Most business is conducted by picture-phone.		
11. Short-term weather forecasting is highly reliable.		
12. Effective world-wide anti-poverty is carried out.		
13. Production of nuclear weapons outlawed and many destroyed.		
14. Drugs to control personality are widely accepted and used.		
15. Computerized medical diagnosis is in wide use.		
16. Human brains linked to computers extend man's intelligence.		
17. Implanting of artificial organs is common practice.		
18. Most people in the world are immunized against common diseases.		
19. Average life span of people reaches 100 years.		
20. Racial barriers are effectively eliminated.		
21. Free public education through college available to all.		
22. Economic and military alliance arises between the U.S. and U.S.S.R.		
23. The U.N. has become a more effective international power.		
24. No war directly involving the U.S. occurs between 1900-2000.		
25. Everyone guaranteed an annual income sufficient to his needs.		
26. Annual investment in automated equipment is 10 times that of 1970.		
27. Average work week is shortened to 32 hours.		
28. Currency is virtually eliminated by credit cards.		
29. Education and arts become lifelong persuits of many.		
30. Maned military space base exists.		

D. Your Predictions:

Based upon your knowledge of the past, of present problems and the viewpoints of experts, complete the chart "Forecasting the Year 2000" by predicting the %-probability of occurrence of each of the items listed. If important items are omitted, in your opinion, add additional items. This is your group's prediction of the future. Turn in your chart. Keep a second copy of your completed chart for up-coming events.

E. Evaluating Your Predictions:

Pit your predictions against those of some experts by playing "Future." Future is a simulation model game for forecasting and planning the Future. The game closely resembles the prediction models used by the computer experts. It calls for:

Strategy--because some possibilities and combinations, some choices for the Future, hold more promise for our goals than do others.

Influence--because with our own efforts and investments each of us has the power to help make things happen the way we want them to happen.

Chance--because there is always the chance that other influences, or some totally unforeseeable development, may affect the future.

The game will be played in three days. The first day will be spent in making predictions of the occurrence of sixty items. The next two days will be spent playing the game. Upon its completion, we will evaluate the results and the reliability of the model on which the game is based. The class will play only game version No. 1. Interested students may wish to try game version No. 2. on their own.

F. Priorities for the Future:

A knowledge of man's present problems and what may happen to him as he approaches the year 2000 surely should interest one in an examination of our national priorities. What are our national priorities? As a people and a nation, we say we stand for and support various things. Probably the best indication of what we stand for and believe in as a nation is our national budget and spending. Look up and record circular diagrams of the national budget for the years 1966, 1967, 1968, 1969, and 1970. Based upon this and any other information you can find, make a large 20" x 30" chart of what our national priorities are now. Based upon what you have learned in this unit, make a second 20" x 30" chart of what you think our national priorities ought to be in the next ten years as we move toward the year 2000. Be prepared to defend your priorities to the class. Recommended reading:

1. The Revolution of Hope Toward a Humanized Technology, by Eric Fromm.
2. Report of the White House National Goals Research Staff. Available from the Superintendent of Document's after July 30, 1970.

Evaluation: Evaluation of the unit will be in two phases:

1. Oral class discussion of relevance, methods and outcomes.
2. A written page by each student outlining what he liked and didn't like about the unit and how it can best be changed.

Student and group evaluation will be done by the instructors.

Participation in groups and group production on the charts will be the items most heavily emphasized.

Possible Class Activities Schedule For

THE YEAR 2000

Days	Activity
1	Orientation and group formation
3	Examination of past history and charts
1	Sm. Group discussion of Kettle book
1	Film: "The Futurists" and discussion
1	Group predictions, turn in first thing tomorrow
1	Groups compare predictions
3	Futures Game
2	Sm. Groups formulate priorities and turn in
2	Groups discuss and compare priorities
1	Evaluation of unit.

Total = 16 days = 4 weeks

RESOURCES

1. Clarke, Arthur C., Profiles of the Future--An Inquiry into the Limits of the Possible, Harper & Row, Publishers, New York, 1962.

2. Fabun, Don, The Children of Change, Glencoe Press, 8701 Wilshire Boulevard, Beverly Hills, California 90211, 1969.

3. Fabun, Don, The Dynamics of Change, Prentice-Hall Inc., Englewood Cliffs, N. J. 1967.

4. Fromm, Eric, The Revolution of Hope Toward a Humanized Technology, Harper & Row, Publishers, New York, 1968.

5. Helmer, Gordon and Goldschmidt, Future, a game of strategy, influence and chance. The game is available to schools upon request from the Kaiser Aluminum and Chemical Corp. Corp. Copyright 1966. Only a limited supply remains.

6. Jungk, Robert, Models for the Future, a taped discussion on using technological apparatus for the betterment of man. The tape can be purchased for $7.50 from The Center for the Study of Democratic Institutions, Box 4068, Santa Barbara, California 93103.

7. Kahn, Herman and Wiener, Anthony J., The Year 2000, The Macmillan Company, New York, 1967.

8. Kaiser News, The Markets of Change Series--1970, Kaiser News is published by Kaiser Aluminum and Chemical Corporation as a kind of exploration of significant subjects for its friends throughout the world. Address Kaiser Center, 300 Lakeside Drive, Oakland, California 94604.

9. Kettle, John, Footnotes on the Future, Methuen Publications, 145 Adelaide St., W. Toronto, Canada, 1970.

10. Time-Life Books Editors, This Fabulous Century, Volumes 1-6, Time-Life Books, New York, 1969.

11. Wall Street Journal, Here Comes Tomorrow, Dow Jones Books, New York, 1969.

12. White House Report, Report of the White House National Goals Research Staff, available from The Superintendent of Documents after July 30, 1970.

13. World Future Society, The Futurist, the bimonthly (6 times/year) publication of the World Future Society, An Association for the Study of Alternative Futures, P. O. Box 19285, Twentieth Street Station, Washington, D. C. 20036.